

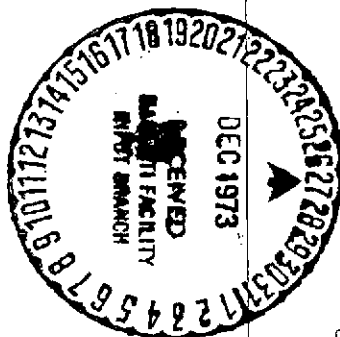
248

new 2/4/22

AIRCRAFT REQUIREMENTS FOR LOW/MEDIUM DENSITY MARKETS

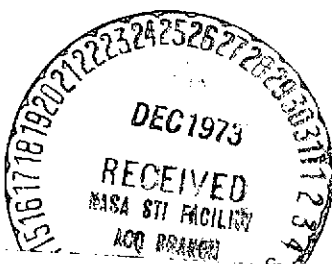
MIT

R. Ausrotas
S. Dodge
H. Faulkner
I. Glendinning
A. Hayes
R. Simpson
W. Swan
N. Taneja
J. Vittek



DEPARTMENT
OF
AERONAUTICS
&
ASTRONAUTICS

FLIGHT TRANSPORTATION
LABORATORY
Cambridge, Mass. 02139



(NASA-CR-137373) AIRCRAFT REQUIREMENTS
FOR LOW/MEDIUM DENSITY MARKETS
(Massachusetts Inst. of Tech.) \$13.50

207 p HC
202 CSCL 01C

N74-19651

Unclas
G3/02 16503

September 1973
FTL Report R73-4

AIRCRAFT REQUIREMENTS
FOR
LOW/MEDIUM DENSITY MARKETS

BY

R. AUSROTAS
S. DODGE
H. FAULKNER
I. GLENDINNING
A. HAYS
R. SIMPSON
W. SWAN
N. TANEJA
J. VITTEK

FLIGHT TRANSPORTATION LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
SEPTEMBER 1973

TABLE OF CONTENTS

Acknowledgements .

1.	Introduction	1
1.1	History	3
2.	Industry and Market Structure	36
2.1	Route Structures	39
2.2	Types of Service	47
2.3	Market Structure	53
3.	Aircraft Analysis	63
3.1	The Price of Transport Aircraft	63
3.2	Aircraft Comparison	72
3.3	Market Potential	86
4.	Economic Analysis	91
4.1	Basic Issues	91
4.2	Subsidy Issues	113
4.3	Freight Potential	123
5.	Field Surveys	127
5.1	Carrier Survey	128
5.2	Community Survey	142
5.3	Manufacturer Survey	148
6.	Computer Network Analysis	154
7.	Summary and Conclusions	192

Acknowledgements

A project such as this would clearly be impossible to undertake without the wholehearted cooperation of the industry: the airlines, aircraft manufacturers, and trade associations. The Flight Transportation Laboratory would like to express its thanks to all those people we contacted during the course of this project and who invariably gave unstintingly of their time and ideas. The following list is almost surely not all inclusive and we apologize to those people who may have been excluded by accident - our thanks to them also:

Curt Haag, Rich Gostyla, Terry Ashdon and Richard Fitzgerald of Hughes Air West

Henry Voss of Golden West Airlines

Joe Fugere of Pilgrim Airlines

R. Price of Executive Airlines

Kingsley Morse of Command Airways

Don Schneller of Wright Air Lines

Edwin Colodny and Robert Jenkins of Allegheny Airlines

G. F. Wallis of North Central Airlines

Preston Wilbourne of Air Wisconsin

Edward Gerhardt, Ben Harris, M.E. O'Neil, and George Smith of Frontier Airlines

Adolf Huettnner of Aspen Airways

Stan Hula and Robert Priddy of Southern Airways

H.K. Sanders, H.M. Cartwright, W.A. Blackmon, George Reynolds, R.W. Kadlec, and C.B. Gimball of Piedmont Airlines

Ken Fosnaught, Bill Olden, and J. Dawson Ransome of Ransome Airlines

Fred Simmonds of Altair Airlines

Al Clark of Beech Aircraft Corporation

///

Del Roskam of Cessna Aircraft Corporation

Russ Wageneck, Dan Gibbs, and Ted Gould of Ozark Air Lines

Tom Garanflo of Houston Metro Airlines

Hermann Farr of Texas International

Jess Coker of Southwest Airlines

Richard Spaulding and William Curtis of Fairchild Marketing Corporation

Frederick Mazzitelli and Charles Coppi of Grumman Aerospace Corporation

Bob Sederman, Don Kelly, Bob Bremer, Tom Higgins, Bill Tuck, George Sarames and Hal Wharton of Lockheed-California

Bob Dutton, Paul Greenlee, Frederick Macey, Jys Ruys and Hal Sweet of Lockheed-Georgia

Dick Black, Jim Burton, Dick Fitzsimmons, Bob Jackson, Chuck Kline, Bob Milton, Bill Parsons, John Stern and R. Underdahl of Douglas Aircraft

Ed Baugh, Howard Tinney, Ed Pina, Hal Higgins, Lloyd Sloan of Boeing

Bob McIntyre and Arthur Toplis of DeHavilland of Canada

Gen. Joe Adams and Thelma Strub of ALTA

Tom Miles, Janet St. Mark, Marty Macy and Debbie Perras of NATC

Walt Berry, Ray Seybold, Lyle Sharp, Calvin Snyder and Fred Weisbrod of Pueblo, Colorado

This work was performed under NASA Contract NASW-2412 for the Office of Aeronautics and Space Technology.

1. INTRODUCTION AND INDUSTRY HISTORY

In 1971, the joint Department of Transportation, National Aeronautics and Space Administrations, Civil Aviation Research and Development Policy Study (CARD) Report, identified the problems of providing air service to low density, short haul markets, as the third most pressing difficulty facing the United States' aviation industry. In the words of the report,

"Low-Density Short Haul: While lower in priority than noise and congestion, solutions to the problems of low-density, short-haul service will be important to the future of civil aviation and to its ability to contribute to the goals of the Nation. This service of civil aviation can be a positive force in future regional development. In order to obtain a better definition of the problems and potential of low-density, short-haul service, a program should be established to determine accurately market sensitivities to changes in service, fare, frequency, and equipment. A government-sponsored market demonstration is required for this purpose. Concurrent and integrated with this demonstration, the Government should fund studies for the conceptual design and analysis of economical vehicles for the low-density, short-haul market."

(Emphasis Added, p. 2-6)

In response to this policy statement, NASA has undertaken a number of technical and systems studies as outlined by Mr. George Cherry, Deputy Associate Administrator for Aeronautics and Space Technology (Programs) in his 1972 testimony before the U.S. House of Representatives' Subcommittee on Aeronautics and

Space Technology of the Committee on Science and Astronautics.

" In FY 73, NASA programs relating specifically to low-density, short-haul will fall into three main categories:

a. Continuing an effort begun in FY 72 which is identifying technology problems associated with providing economical air service to sparsely-settled regions.

b. Continuing an effort begun in FY 72 which will investigate and develop very-low-frequency navigation techniques for en route and terminal area navigation for civil aviation, especially low-density, short-haul service.

c. Increasing knowledge of economic and operational factors which bear upon technology and aircraft requirements. Studies will be undertaken to fit existing and hypothetical aircraft into realistic low-density, short-haul arenas and to identify where and why economic short-comings appear. Those that can be improved by technology will be identified. In addition, programs will be undertaken to investigate: ride-quality improvement as it influences aircraft design and passenger acceptance, crosswind landing characteristics, and operational techniques."

This study attempts to answer some of the questions in Item C.

1.1. A HISTORY OF LOCAL AIR SERVICE REGULATION IN THE UNITED STATES

Small Community Air Service

Since 1961 the number of places in the United States receiving certificated airline service has decreased by 250 from 729 to 479 points.¹ Despite the fact that in 1972 commuter carriers exclusively served an additional 174 airports, it is difficult not to conclude that the scope of air transportation has deteriorated.² Although exact numbers do not exist, the report of the Aviation Advisory Commission estimated that from 300-500 communities were more than one hour's drive from a certificated scheduled air service airport and therefore possible candidates for subsidized air service.³ What the cost would be if all these communities were to receive regular air transportation has not been calculated, but a similar proposal in 1943 to provide direct air service to all urban communities was estimated to involve a cost to the government of between \$109-150 million annually.⁴ Allowing for increases due to inflation over the past thirty years, that cost might well represent a reasonable estimate for the present, considering that the federal subsidy to air carriers in 1972 was over \$67 million.⁵

¹ CAB Annual Reports 1962 Annex 4, 1971 Table 1, and The Long Range Needs of Aviation p. VI-146.

² The Long Range Needs of Aviation p. VI-146.

³ Ibid. p. VI-146.

⁴ 6 CAB 1 p. 49.

⁵ "Subsidy for United States Certificated Carriers" August 1972, Appendix VII.

Federal involvement with local air service began with, the Investigation of Local, Feeder, and Pick-up Air Service initiated in March 1943, and since then the Civil Aeronautics Board has tried a number of policies in the attempt to provide these services on a sound economic basis.⁶ Unfortunately, the same two problems have consistently proven insurmountable: the insufficiency of traffic and the lack of a suitable aircraft. The CAB's difficulties have been compounded by the traditional abhorrence of a continuing government subsidy, on the part of Congress and the Executive, coexistent with an equally strong desire to provide air service to small communities. It is interesting to note that the CAB policies and many of the recurring suggestions for solution of the local air service problem were all considered in the original 1943 investigation.

During that investigation, the already certificated carriers proposed that small community air service should be accomplished on a "self-sufficient" basis by authorizing additions to existing routes. Service to the new points would be cross-subsidized by the carriers' profitable long-haul markets. The existing airlines proposed at that time to make considerable use of "skip-stop" schedules providing service at the small communities in accordance with traffic volume. They claimed that their use of comfortable modern aircraft and the possible provision of single plane through

⁶ Docket No. 857 6 CAB 1.

service would stimulate demand at many small points.⁷ These same arguments were later advanced by the local service carriers and with its route-strengthening program starting in the mid-sixties, the CAB adopted that very policy in awarding them profitable long-haul routes.

The examiners also suggested in 1943 that if special feeder carriers were to be established and the growth of the trunks consequently limited, then a balancing limitation should be imposed on the feeder carriers. It was recommended that they be strictly limited to feeder services only and that "(a)n inclination to grow in the other direction, that is, to nonstop smaller cities and reach out for big city traffic to the detriment of other carriers should be discouraged at the outset."⁸ Despite initial CAB discouragement, this "inclination" soon became the major goal of local service carriers in their desire to attain small or "junior" trunk status, a goal that has effectively been reached by Allegheny, following its recent acquisition of Mohawk, as is apparent in its request for major trunk routes, even at the expense of foregoing subsidy.

The operating authorizations of feeder routes have historically reflected the two theories concerning traffic flows that existed in 1943. An analysis of rail and air traffic showed that "the preponderant movement of the traffic

⁷ Ibid. pp. 29-30.

⁸ Ibid. p. 55.

of small communities is to and from large cities, rather than between numbers of small cities."⁹ On the other hand bus data indicated that on relatively long routes connecting two major market centers a substantial amount of the traffic was of an "on-and-off" nature travelling between intermediate points.¹⁰ The conclusion of the examiners was that a reasonable feeder service would be one which catered to both types of traffic, travelling between two substantially large terminal cities, with a number of intermediate points; that, however, the feeder carrier should have some degree of lee-way in arranging skip-stop schedules, although nonstop service should be prohibited between two points designated on the certificate of an existing carrier.¹¹ The CAB has gradually liberalized initially restrictive authorizations requiring feeder schedules to stop at every designated point, but, even with subsequent segment realignments, this policy remains evident in most local-service routes.

The question of a suitable local-service aircraft was also dealt with in the 1943 investigation which found that a specially designed airplane was necessary. The requirements envisioned at that time were for a 12 passenger (3,000 lb. payload) multi-engined aircraft with a 150-180 mph cruising

⁹ Ibid. p. 14.

¹⁰ Ibid. p. 18.

¹¹ Ibid. p. 55.

speed and an operating cost of about 40¢ per aircraft revenue mile.¹² Requirements remarkably similar to those of the Association of Local Transport Airlines' (ALTA) Small Plane Design Committee issued twenty years later in 1963, which called for an 18 passenger airplane, a cruise speed of greater than 300 mph, pressurization (which did not exist commercially in 1943 on any aircraft), and operating costs of 40¢ per aircraft mile - although the CAB felt that 60¢ was a more reasonable goal.¹³ Aircraft of this type finally became available in the late sixties with certification of turbine powered Twin Otters and Beech-99's, which have subsequently played an important role in the recent rapid development of the commuter carriers, who operated 171 of them in 1971.¹⁴ Otherwise, few aircraft have been specifically designed to meet these requirements and local air service has generally been provided by aircraft unsuited to the purpose.

The CAB discouraged early attempts of the local service carriers to acquire more advanced aircraft with capacities deemed too large for the markets they served. In 1953, an application of Pioneer for increased subsidy due to the operation of Martin 202's was rebuffed by the Board and may well have been one factor leading to that carrier's later merger with Continental.¹⁵ However, following permanent

¹² Ibid. p. 41.

¹³ Service to Small Communities: Part II p. 18.

¹⁴ Commuter Air Carrier Traffic Statistics - Year Ended December 31, 1971. Table 15.

¹⁵ Service to Small Communities: Part II p. 12

certification in 1955, the CAB relaxed its position and the local service carriers began to operate substantial numbers of more modern aircraft in place of the DC-3's used previously. As these aircraft were generally far larger than the DC-3's and without a suitable DC-3 equivalent, the carriers started to decrease and discontinue service at "marginal" communities. The rapid acquisition of jet aircraft beginning in the mid-sixties only accentuated the problem of small-city service and accelerated the withdrawal. With the loan guarantee aircraft purchase program of the late fifties and the route strengthening policy of the sixties designed around the operations of larger aircraft the CAB seems to have encouraged, or at least abetted, the corporate goal of the local service carriers to achieve "junior trunk" status.

Subsidy

In section 406 of the Civil Aeronautics Act the CAB is directed to fix and determine "fair and reasonable rates of compensation for the transportation of mail by aircraft." This must be done in such a manner as to "maintain and continue the development of air transportation to the extent and of the character and quality required for the commerce of the United States, the Postal Service, and the national defense." From 1938 until October 7, 1953 the Postmaster General paid the total compensation to meet the "needs" of the air carriers as calculated by the CAB; since then airmail

service compensation and subsidy have been formally separated, with the CAB responsible, through Congressional appropriation, for payment of the subsidy element.

Prior to January 7, 1961 the CAB determined all subsidy needs on an individual carrier basis. Due to the rapid expansion and continuous modification of the local service carriers' route structures after their permanent certification, this system proved inappropriate for these carriers, often leaving them in a position where their subsidy rate was undetermined. Finding that this impaired the carriers' ability to operate efficiently and plan for the future, the Board established a "class subsidy rate" effective January 1, 1961, based on the average costs of the group and using standard investment criteria developed by the CAB from analysis of the carriers' requirements. Since its initial adoption the class subsidy rate formula has been modified eight times with the last, Class Rate VI, effective July 1, 1971.¹⁶

Similar to those of its predecessor, the objectives of Class Rate VI, adopted June 16, 1972, are: "to relieve the industry's still critically depressed financial condition; to equitably distribute the subsidy payments consistent with the changing needs of the individual carriers; and to establish a class rate formula that will identify the subsidy related

¹⁶ "Subsidy for United States Certificated Air Carriers" August 1972 pp. 9-10.

to services at and between communities and provide positive incentives for the local service carriers to maintain adequate services to the small communities."¹⁷ A further objective is to encourage small aircraft service at low traffic-generating communities.¹⁸

In spite of their objectives, the last two class rates have not been able to prevent the local service carriers from diminishing service at smaller communities, nor have they been able to encourage the use of small aircraft. They have had the definite effect of doubling the subsidy pay to the carriers from \$34.3 million in 1970 to \$62.8 million in 1972.¹⁹ Cross-subsidization through route strengthening has also proven inadequate and, although three local service carriers earned enough in 1971 on their ineligible routes to provide a degree of cross-subsidization, the industry is not expected to become subsidy free in the near future.²⁰

The only other group of carriers currently receiving subsidy are the Alaskan Airlines, whose requirements have slowly decreased from a high of \$9.7 million in 1963 to their current level of approximately \$4.5 million, less

¹⁷ Docket No. 23682 p.2.

¹⁸ Ibid. p. 23.

¹⁹ "Subsidy for United States Certificated Carriers" August 1972 Appendix VII.

²⁰ Ibid. p.5.

than 7% of the total federal payment.²¹ Due to pressure from Congress and the Executive, subsidy has ceased to be paid to the other eligible carrier groups.²²

Citing changes in the small community transportation system over the past decade and difficulties in assessing the effectiveness of the present subsidy program, the CAB in its 1972 Annual Report to Congress has proposed a new method for providing air service to small communities. This would take the form of a contract system between the CAB and the carriers for services determined by the Board. The amount of subsidy would be predetermined through the carriers' bids, with no renegotiation permitted and no follow-on contracts assured, while the performance of the carrier during the life of the contract would be ensured by financial guarantees. As with the original 1943 "experiment" in local air service, the new system would initially be conducted on a limited 3-year trial basis in various areas of the country.²³

²¹ Ibid. Appendix VII.

²² Subsidy to the Helicopter carriers was eliminated after 1965, to the Hawaiian carriers after 1967 (except for 1969 when Aloha received \$0.8 million), and to Northeast Airlines after 1968.

²³ CAB Annual Reports to Congress Fiscal 1972 pp.10-11, 84.

Development of the Carriers

Local Service

When the CAB began to resume its normal functions towards the end of World War II, the number of applications for "local" and "feeder" air transportation were so numerous that a general investigation into these services was instigated on March 22, 1943 to determine "...the propriety of extending air transportation to communities and localities throughout continental United States to which such transportation may not appear warranted under usual economic considerations or existing standards of operation, and the coordination of such transportation with air transportation presently authorized under usual considerations and existing standards."²⁴

The Investigation of Local, Feeder, and Pick-up Air Service was not particularly optimistic in its determination of "...the extent to which small cities need and would use air service..."²⁵ However, the CAB felt that its obligations to promote and encourage civil aeronautics under the 1938 Act, together with the enthusiasm of the applicants and the general lack of experience with this type of air service, warranted a trial experiment on a subsidized basis. It was noted that these short-haul, low-density air services would

²⁴Annual Report of the CAB 1943 p.11.

²⁵⁶ CAB 1 p.1.

face severe competition from surface modes of transportation, and as a safeguard against static or increasing dependence on the Government, temporary three-year certificates would be authorized, confined "...to operations which show a justifiable expectation of success at a reasonable cost to the Government."²⁶

Following its decision of July 11, 1944, the CAB held a series of consolidated area proceedings and by 1949 twenty new local service carriers had been certificated.²⁷ In the first of these cases, Service in the Rocky Mountain States Area, decided on March 28, 1946 the CAB stated its "guiding principals" in awarding local air service authority.²⁸ These included: prospects for success; benefit to the community; distance to the normal metropolitan trading center; time of travel by surface modes compared to air, including travel time to and from the airports used; the comparative frequencies of surface and air schedules; geographic conditions, especially mountainous terrain; and the financial cost to the Government. In awarding authority for these expanded air services to new carriers over existing airlines, the CAB expected that local operators with small aircraft would use greater effort and ingenuity in meeting the needs of small communities.

²⁶ Ibid. p.3.

²⁷ One carrier, Essair (later to become Pioneer Airlines), had been previously awarded authority on November 5, 1943, although service was not begun until April 19, 1945.

²⁸ 6 CAB 695 p.731.

By the mid-fifties the local service carriers, coming up for their second and third renewals under temporary status, were seeking more permanent existence. In hearings before the House Committee on Interstate and Foreign Commerce they argued that permanent certification was necessary because of the difficulties and increased costs of operation on a temporary basis.²⁹ They stated that renewal proceedings consumed time and money which could be better spent improving the operations of the carriers, while their uncertain future discouraged aircraft manufacturers from designing an aircraft tailored to the requirements of the local-service airlines and precluded the economic advantage of long term arrangements for hangars, navigational equipment, and maintenance facilities.

The CAB opposed such a move asserting that local air service had not yet reached maturity and that permanent certification would make improvement in the route systems of the several carriers much more difficult.³⁰ It was felt that with permanent certification the carriers' incentive to increase revenues and hold down costs would be lessened and the Government would be saddled with an annual subsidy bill of "over \$20 million" for the indefinite future. Reference was made to the fact that many of the costs of operation

²⁹ Hearings on "Permanent Certificates for Local Service Air Carriers" pp.30-31.

³⁰ Ibid. p.135.

were held down precisely because of temporary status. With permanent certification, the costs of labour and airport services were predicted to increase substantially. At 47 percent, the CAB claimed that the average proportion of subsidy to total revenues was too high, and in addition presented evidence that the costs of recertification were not excessive, that it was the accompanying requests for expanded authority which were expensive. Finally, the CAB argued that it was the market, not the carriers which determined the development of new aircraft and that the Board would favor legislation to aid local-service airlines in the financing of new equipment.

In spite of the CAB objections, Public Law 38 was passed on April 19, 1955 amending the Civil Aeronautics Act to allow permanent certification of the local service airlines under "grandfather" provisions. The CAB then moved to expedite such certification to the 13 air carriers then in existence: Allegheny, Bonanza, Central, Frontier, Lake Central, Mohawk, North Central, Ozark, Piedmont, Southern, Southwest, Trans Texas, and West Coast.³¹ The law required that all terminal points and at least one half the intermediate points should receive permanent authority ; the rest at the discretion of the Board, which subsequently determined

³¹ There had been 14 at the time of the hearings but Pioneer had merged with Continental on April 1, 1955.

that an average of five or more enplaned passengers per day was necessary to receive certification.³²

The CAB then embarked on a series of twelve area cases "...to determine the over-all needs for local-service air transportation and the extent to which the local air carriers could fulfill these needs."³³ In the Seven States Area Investigation, decided on December 8, 1958, the "use it or lose it" policy was introduced whereby a community could receive air service if for the year following the initial six months it met the minimum standard of an average of five enplaned passengers daily; although continued service was not assured to cities enplaning the bare minimum. At the same time more liberalized operating authority called "skip-stop" was granted to the local service carriers. As long as two daily roundtrips were scheduled to intermediate points, the carriers could provide nonstop service between non-competitive terminal points or one stop between competitive terminal points. The feasibility was also reviewed of deleting the authority of trunkline carriers in certain markets where local service could provide "...equal, additional, or improved..." air transportation to the communities involved.³⁴

³² CAB Handbook of Airline Statistics 1971 p.485.

³³ CAB Handbook of Airline Statistics 1971 p.487.

³⁴ Ibid. p.487.

The result of these cases was that by the end of 1963 the unduplicated route miles of the local service carriers had increased by 37% and their annual subsidy requirement had more than doubled over its 1958 value, reaching \$67.7 million, or about \$7.64 per scheduled passenger enplaned.³⁵ In his April 1962 message to Congress on transportation, President Kennedy called for reductions in the subsidy payments to the local carriers and requested a specific step-by-step program from the CAB by mid-1963. In response to the President the CAB stated that most subsidy saving would come from increased local-service airline revenues as a result of a period of stabilization after recent rapid route growth and equipment modernization, but that savings would also come from a gradually reduced subsidy standard on high density routes, a consolidation of airports, and a continuation of the "use it or lose it" program.

The subsidy requirement began to come down and by 1966 the policy had been further broadened by awarding certain high-density, short and medium haul markets to the local service carriers on a subsidy ineligible basis, "...even in instances where such an award may involve competition with trunkline service."³⁶ Other routes, marginally profitable for the trunks, were transferred to the locals, while numbers

³⁵ CAB Reports to Congress Fiscal 1968 p.113, CAB Handbook of Airline Statistics 1971 p.54, and "Subsidy for United States Certificated Air Carriers" August 1972 Appendix VII.

³⁶ CAB Reports to Congress Fiscal 1966 p.4.

of existing segments were consolidated in a variety of realignment investigations. In this manner the operating authority of the local service carriers was extended into regions outside of their historic markets, connecting them with an increased number of large traffic-generating hubs.

Finally, in 1967 the CAB began the practice of authorizing local service carriers to fulfill their certificate obligations through substituted service by commuter airlines. However, the local service carrier continues to bear the responsibility of ensuring adequate service in these substituted markets as required in its certificate and must be prepared to reinstitute service if the commuter should fail. By October 13, 1970 the CAB had authorized local service carriers to suspend service at 39 points where replaced by commuter carriers providing an adequate level of service.³⁷ On January 15, 1968 Subpart M of Part 302 was adopted to expedite procedures in the modification or removal of certain stop restrictions in the local service carriers certificates. In that year also a series of mergers reduced the number of locals to nine and the merger of Mohawk with Allegheny in 1971 brought them to their present level of eight carriers: Allegheny (Mohawk, Lake Central),

³⁷ Service to Small Communities: Part II p.29 - for further information see section on commuters.

Frontier (Central), Hughes Air West³⁸ (West Coast, Bonanza), North Central, Ozark, Piedmont, Southern, and Texas International.³⁹

Hawaiian

Regular air passenger service between the Hawaiian islands was begun on November 11, 1929 by Inter-island, a carrier owned substantially by a shipping company. Following the depression, traffic began to pick up and in 1938 Inter-island was the only Hawaiian carrier to receive a certificate of public convenience and necessity under the "grandfather" provisions of the Civil Aeronautics Act. For a while it continued to be the only air carrier offering legal scheduled services within Hawaii and during the war provided the only means of transportation between the islands. By this time the name Hawaiian Airlines had been adopted and after 1943 the carrier operated free of subsidy. By 1948 air transportation had again become the only common carrier passenger service between the islands.⁴⁰

In the Hawaiian Intraterritorial Service investigation the CAB found that "(i)n view of the unique dependence of Hawaii upon air transportation, its importance to the

³⁸ Formerly Air West, Pacific Air Lines, and Southwest Airways.

³⁹ Formerly Trans-Texas Airways.

⁴⁰ World Airline Record 1972 p.424.

economy and people of the territory, and absent a showing that a second carrier will seriously impair the ability of the existing carrier to render adequate and economical service, public interest requires authorization of additional air transportation service."⁴¹ Thus on April 19, 1949 Trans-Pacific Airlines, later called Aloha, was authorized to carry persons and property over routes nearly duplicating those of Hawaiian. Although Aloha was originally not permitted to carry mail and receive subsidy, substantial losses in the first year of operation caused the carrier to request and receive airmail and subsidy eligibility from the CAB. At the same time the traffic diversion due to competition was such that Hawaiian also successfully applied for reinstigation of subsidy assistance. By fiscal 1952 the total annual subsidy of the two carriers had jumped to \$715 thousand, almost twenty times greater than any amount received previously.⁴²

Even with financial aid from the Government the carriers were barely profitable when, under pressure from Congress, the subsidy support to the two airlines was discontinued after fiscal 1967. Their position was further aggravated on September 26, 1967, after the CAB authorized three domestic trunks to provide direct mainland service to

⁴¹10 CAB 62 p.66.

⁴²"Subsidy for United States Certificated Air Carriers" August 1972 Appendix I.

Hilo as well as Honolulu as a result of the Transpacific Route Investigation. Although the carriers have almost continuously operated at a loss since then (substantial in the case of Aloha) they have not received any further subsidy except for 1969 when Aloha was granted \$789 thousand.⁴³ In 1970 special permission was given to the two to engage in mutual capacity reductions. In 1971 a proposed merger, already recommended by the CAB hearing examiner, fell through when Hawaiian withdrew because of unsatisfactory financial prospects for the merged carrier, but in 1972 the merger was once again under consideration by the CAB.⁴⁴

Alaskan

The inherent advantages of air service over surface forms of transportation are nowhere more apparent than in Alaska with its rugged terrain and long distances between communities. At the time of the Civil Aeronautics Act in 1938 most of the territory's mail and a substantial amount of freight were already carried by air. Recognizing that special conditions existed, the CAB temporarily authorized the Alaskan air carriers to continue operations without

⁴³Ibid. Appendix VII.

⁴⁴World Airline Record 1972 p.426.

regulation pending investigation into the requirements for air transportation in Alaska.

Begun in 1939, the Alaskan Air Transportation Investigation was prolonged by the War until December 5, 1942 when the CAB granted subsidy eligibility and certificates of public convenience and necessity to twenty-one carriers.⁴⁵ An interim report had emphasized the importance of air transportation to Alaska, noting that many communities were virtually inaccessible by any surface mode, and that a four hour plane trip from Fairbanks to Nome costing \$78 had replaced a thirty day journey by dog team costing \$500.⁴⁶ The report had also foreseen that modifications in the domestic U.S. air transportation regulations would probably be required due to the special requirements in Alaska.

This was the case as the certificates issued to Alaskan carriers authorized both "regular" and "irregular" routes. The "regular" routes, while similar to those of the domestic airlines, also permitted the carriers to serve additional unnamed intermediate points within their area if they required service. "Irregular" routes designated areas within which a carrier was free to provide air transportation in any manner suited to the traffic demands,

⁴⁵ Pan Am had previously been awarded some regional authority along with its mainland-Alaska routes.

⁴⁶ Annual Report of the CAB Fiscal 1941 p.10.

including a regular-route service. Charter trips and other special services originating at or destined for points on regular or irregular routes were also permitted as long as they were of a casual, occasional, or infrequent character and did not result in establishing a regular scheduled service.⁴⁷

Even as the certificates were authorized a number of the Alaskan carriers were about to merge or had ceased operating. This condition remained for the next decade or so as the CAB continued to investigate the conditions of air transportation in Alaska. In accordance with these conditions a policy was adopted in 1948 of exempting "pilot-owners" from many of the economic regulations. With letters of registration, qualified pilots using small aircraft could perform specialized air transportation services as long as they were solely within Alaska and not between points receiving a total of three or more scheduled flights a week by certificated carriers.⁴⁸

In 1953, the CAB began another comprehensive review of air transportation in Alaska. As with the previous investigation, the Intra-Alaska Case dragged on and was not decided until January 14, 1959. In the meantime seven

⁴⁷Annual Report of the CAB Fiscal 1943 p.14.

⁴⁸Annual Report of the CAB Fiscal 1948 p. 35.

Alaskan carriers had been granted permanent certificates on December 31, 1956 in accordance with Public Law 741.⁴⁹ The Intra-Alaska Case authorized a number of route adjustments and deletions of points no longer requiring service. It established regional local service by intra-Alaskan airlines certificating two new carriers, authorized mainland Alaska service by two carriers, and terminated Pan American's local authority within Alaska.⁵⁰

A further investigation of Alaskan air service was commenced by the CAB in 1969. Called the Alaska Service Investigation, only the trunk phase has as yet been completed, a second bush phase awaiting the Board's decision. As with previous cases, the investigation involves massive restructuring of air transportation within and to and from Alaska. In the meantime, mergers have reduced the number of carriers to five: Kodiak, Reeve Aleutian, Western Alaska, Wien Consolidated (from the merger of Wien Alaska and Northern Consolidated), and Alaska Airlines (Cordova, Alaska Coastal, Ellis). One Alaskan carrier, called Pacific Northern, merged with the domestic trunk Western Air Lines and presently pending is yet another merger between Kodiak and Western Alaska, the two smallest carriers.

⁴⁹ Annual Report of the CAB Fiscal 1957 p.5.

⁵⁰ Annual Report of the CAB Fiscal 1959 p.9.

Most Alaskan traffic is carried by Alaska and Wien Consolidated, which also receive 95% of the subsidy.⁵¹ Interestingly, Reeve Aleutian has operated since 1957 without subsidy assistance. Its consistently profitably operations are attributed to: "(1) the absence of ruinous competition, (2) relatively high overall load factors, (3) good cargo business and (4) the especially heavy movement of high revenue mail."⁵² In 1970 the mail load was 85% of the passenger traffic, measured in ton-miles, while mail and freight together exceeded the passenger traffic by 20%. Passenger fares averaged 8¢ per mile and mail and cargo about 60¢ per ton-mile.⁵³

Helicopter

Numerous applications for helicopter service were considered during the 1943 Investigation of Local, Feeder and Pick-up Air Service, including a comprehensive transportation plan involving mixed helicopter and bus operations proposed by the Greyhound Corporation. However, the CAB ruled that it could not be expected to grant applications for helicopter service until suitable commercial vehicles could be developed; though the Board did not preclude the

⁵¹"Subsidy for United States Certificated Carriers" August 1972 Appendix VIII.

⁵²World Airline Record 1972 p.454.

⁵³Ibid. p.454.

use of helicopters, when they became available, by already certificated carriers. In fact, as early as July 6, 1939, for one year Eastern Air Lines had operated a scheduled airmail service using an autogiro.⁵⁴

The first regular helicopter service was not initiated until October 1, 1947 when Los Angeles Airways (LAA) began to carry mail over three routes in the Los Angeles region. Subsidy eligibility and the authority for the carriage of mail and property only was granted by the CAB in a temporary three-year certificate similar to those being issued to the local service carriers during the same period. Further certificated helicopter operations were begun on August 20, 1949 around Chicago by Helicopter Air Service (CHA) (later called Chicago Helicopter Industries and finally Chicago Helicopter Airways) and three years later in the New York area by New York Airways (NYA) which also received passenger authority. On July 5, 1951 the LAA certificate was renewed for five years and amended to allow the carriage of passengers under an area concept, comparable to the Alaskan "irregular" routes, in which the carrier was exempted from formal certificate hearings when modifying its route pattern. The Chicago carrier received similar expanded passenger authority on June 7, 1956.

⁵⁴ CAB Handbook of Airline Statistics 1971 p.452.

The three carriers flew only mail until 1951 when they began to carry freight, followed by the inauguration of the first passenger services by NYA on July 9, 1953. Prior to the carriage of passengers all of the mail compensation received by the helicopter carriers was designated as service mail pay and no numerical estimate is available of the degree to which their operations were subsidized, although experience in the following years indicates that it must have been considerable. On November 26, 1963 a fourth and final CAB certificate was granted on a nonsubsidy basis to San Francisco and Oakland Helicopter Airlines (SFO), which had been operating since 1961 as an intra-state and air taxi carrier. At the same time the Board denied all applications for subsidized helicopter services in the Washington, D.C. - Baltimore area.

The reason for the CAB's action was that starting with fiscal 1962, Congress had begun to impose subsidy ceilings on the operations of the helicopter carriers. Concerned with the continuing high level of these carriers' requirements for financial assistance relative to the service provided, Congress authorized decreasing amounts of subsidy in each of the years following, finally cutting off all subsidy at the end of calendar 1965. Without financial assistance from the Government, the helicopter carriers

were only able to continue operations through the support of the regular scheduled airlines. SFO, which had never received Government aid was no better off, having operated at a loss from the first despite substantially higher fares and an advantageous route pattern. By 1965 SFO's accumulated deficit had wiped out its stockholders' equity and it also requested help from the regular airlines.⁵⁵

Earlier, the helicopter carriers had received a form of indirect subsidy from the other airlines through the absorption of some of the relatively high helicopter fares for passengers with interline tickets. After 1965 more direct aid was also given in the form of loans and free operating assistance. Despite this help and despite the substitution of less expensive STOL aircraft operations on some routes, the helicopter carriers continued to operate at a substantial loss. Financial difficulties forced more limited operations which, together with improved airport ground access, in turn decreased passenger appeal and reduced revenue traffic, while increasing unit costs.

As a result of these difficulties, LAA ceased to operate on October 7, 1970; CHA provides only a minimum of service and ceased scheduled operations entirely for the three years 1966-1968 until the regular airlines restarted

⁵⁵World Airline Record 1972 p.455.

service to Midway airport; SFO is in bankruptcy and operates under trusteeship; and only NYA, under control of Pan American and TWA since May 23, 1966, provides any significant service, which is nevertheless barely one half of its 1967 level. In 1969 a five-year temporary certificate was awarded to Washington Airways for helicopter service in the Washington, D.C. - Baltimore area. Lacking downtown Washington heliport site, service was never initiated and the case is once again under CAB consideration.

Air Taxis, Commuters, and Others

After the CAB assumed authority under the Civil Aeronautics Act for the regulation of air transportation, one of its first actions was to adopt Regulation 400-1 on October 18, 1938 exempting from the economic and safety provisions of the Act all carriers engaged in non-scheduled operations only. The Investigation of Non-scheduled Air Services begun in July 1944 concluded on May 17, 1946 that the distinction between scheduled and nonscheduled carriers was fundamental and continued the exemption requiring only that the carriers report certain organizational and operational data. The knowledge so gained caused the CAB to create a new class of carriers called "noncertificated irregular carriers". Those operating aircraft of under 10,000 pounds gross take-off weight (amended to 12,500 lbs. on October 5, 1949) were classified as "small irregular carriers" and subjected to a minimum of economic regulations.

A letter of registration was required and any regular service between two points prohibited.

Under Economic Regulations, part 298 enacted February 20, 1952 the CAB recognized that the small irregular carriers were not competitive with the certificated route carriers and authorized them to provide regular service connecting small communities, not served by the scheduled carriers, with points so served. This authority was virtually unlimited within the continental United States and between the U.S., and foreign and overseas points, prohibited only between points receiving helicopter service. Operations were restricted within U.S. territories and possessions and banned entirely in Alaska where it was felt that the need for supplementary service was amply met by the various existing classes of Alaskan air carriers. The regulation also changed the name of the carriers to "air taxis" to more nearly reflect the nature of the services performed and to encourage their use by the public.

The authority to carry mail was withheld until November 4, 1965 when Part 298 was amended to allow mail service, on an unsubsidized basis, for a three year period. This initial authority applied only within the continental United States and Hawaii in markets where no certificated carrier held active authority. Further amendments that year eliminated prior restrictions on operations within

U.S. territories and possessions, removed the prohibition on regular services between points served daily by a certificated carrier, and liberalized operating authority in Hawaii. Certain market and rate restrictions accompanied the new authority to carry mail in order to safeguard the interests of the certificated carriers. Air taxis were prevented from operating in markets in which on-line service was authorized to a single certificated carrier, while a final rate had to be established before the carriage of mail could begin.

Since 1965 Part 298 has been further amended several times extending and expanding the operating and airmail authority of the air taxis, including permission to carry mail in competitive markets. Most notable was the recent modification of the aircraft size limitation permitting the use of aircraft with up to thirty passenger seats and a payload capacity of 7,500 pounds. Prior to this the use of large aircraft had been authorized by exemption in a number of special markets and areas.

In 1969 another amendment to Part 298 was issued, requiring all air taxi operators to register annually and designating as "commuter air carriers" "those operators which perform, pursuant to published schedules, at least five round trips per week between two or more points." Previously

referred to as third-level carriers, they are required to file quarterly reports of their operations. Apart from the restrictions discussed above, the CAB exercises no other regulatory control over commuter carriers and with freedom of entry and exit the turnover rate is quite high. A number of operators fail, but, generally starting out as regularized air taxis, most commuters revert to their former status if unable to operate successfully as scheduled carriers; others may only provide scheduled operations on a seasonal basis.

On July 17, 1967 Apache, a schedule air taxi, was authorized to provide substitute service for American Airlines at Douglas, Arizona.⁵⁶ Rapidly thereafter suspension of certificated carrier operations at marginal points in favour of commuter carriers has become a major CAB policy. As of October 13, 1970 substitution had been permitted at fifty-five points, thirty-nine for local service carriers and twenty-six for trunks.⁵⁷

In many cases applications for suspension/substitution have involved a service agreement between the commuter and the certificated carrier. The nature of the agreements has varied, but the most comprehensive have been those contracted

⁵⁶ CAB Reports to Congress Fiscal 1968 p.119.

⁵⁷ Service to Small Communities: Part II p.29.

under the "Allegheny Commuter" program.⁵⁸ Subject to CAB approval, Allegheny has selected its commuters, awarded them ten-year contracts, and guaranteed a breakeven financial result during the first two years through subsidy. Carriers so chosen go by the name "Allegheny Commuter", painting their aircraft in Allegheny colours and offering joint fares. Allegheny provides its computerized reservation service, interline ticketing and baggage handling, and includes the complete schedules of the commuters in its own timetable. In return Allegheny requires that the commuter carry the same level of liability insurance as it does itself, that flights are crewed by a uniformed captain and first officer and operated at a 95% completion factor.

In 1952, 1,442 air taxis held letters of registration with the CAB compared to 1,900 registered during fiscal 1972; of those registered in 1972, 185 were commuter air carriers.⁵⁹ According to Board policy, statistics are only published after one year, and in 1971, 160 carriers reported (only 107 reporting all four quarters) having carried 4,925,000 passengers, 27,720 tons of cargo, and 50,616 tons of mail. An average of 65,710 flights were made each month, serving 466 airports.⁶⁰

⁵⁸ Ibid. pp.35-38.

⁵⁹ Annual Report of the CAB Fiscal 1952 p.8 and CAB Reports to Congress Fiscal 1972 p.12.

⁶⁰ Commuter Air Carrier Traffic Statistics - Year Ended December 31, 1971 p.1.

Prior to giving air taxis scheduled service authority in 1952, the CAB had temporarily certificated a number of commuter services in the forties on a nonmail (nonsubsidy) basis. Most of the certificates were never renewed due to failure to initiate scheduled services; however, more recently a few certificated commuter type operations have been operated under the CAB classification of "Other" carriers.⁶¹

On January 11, 1960 Avalon Air Transport was authorized to carry passengers, property and mail, without subsidy assistance, between Santa Catalina Island and the Los Angeles area. This service had previously been abandoned in 1955 by Catalina Air Transport certificated under the "grandfather" provisions of the Civil Aeronautics Act. Avalon itself only operated as an other carrier until its temporary certificate expired after which time it continued service as a regular air taxi. In 1966 Aspen Airways, having operated as an air taxi since 1953, requested a certificate for its operations between Denver and the ski resort. A certificate was granted on a nonsubsidy basis in June 1967 and since then two other carriers have been

⁶¹When the term "domestic service" was amended on January 1, 1970 to include operations within the 50 states, the international and territorial classification of Alaska Airlines was changed to other.

similarly authorized, Tag Airlines in November 1969 and Wright Air Lines in July 1972. Tag later suspended operations in August 1970 and a merger between it and Wright is currently before the CAB.

2. INDUSTRY AND MARKET STRUCTURE

Grouping airlines as local service or commuter carriers does not adequately describe either the characteristics of a particular carrier, the markets served, the route patterns used or the services provided. For example, Table 2.1 lists some statistics for the continental local service carriers. Using this data, they can be divided into at least three subgroups. First, Allegheny stands by itself as by far the largest and most trunk-like local service airline. In fact, it boards more passengers than several trunks. The second group is composed of Frontier, Hughes Airwest and North Central. Each of these is characterized by extensive route mileage (6,500 to 8,500) and a high number of stations (70 or more). The third group are the four smaller carriers; Ozark, Piedmont, Southern and Texas International. Each has a route network of less than 6,000 miles and serves 50 to 55 stations. These smaller carriers also tend to be concentrated in one geographic region even though they do have some long haul routes. This makes their choice of equipment easier since most points in their systems have similar weather and geographic features. In contrast, a larger carrier like Frontier must operate in Montana winters, Texas summers, Arizona deserts, and Colorado mountains.

The commuter industry is also quite diversified. Some of

TABLE 2.1
Local Service Statistics - 1972^(a)

	Allegheny	Frontier	Hughes* Airwest	North Central	Ozark	Piedmont	Southern	Texas International
Number of Stations	74	91	74	70	53	50	55	55
Revenue Passengers (000)	10,096	2,616	2,558	4,319	2,984	3,179	2,101	2,161
Revenue Passenger Miles (000)	2,961,662	1,099,503	891,890	1,029,193	819,703	885,633	596,197	666,353
Available Seat Miles (000)	6,076,500	2,118,882	1,875,093	2,048,133	1,668,165	1,769,273	1,279,175	1,374,167
Revenue Ton Miles (000) (Mail, Express, Freight)	35,878	12,743	5,985	12,181	10,662	8,765	6,963	7,193
Average Load Factor	48.7	51.9	45.0	50.3	49.1	50.1	46.6	48.9
Number of Aircraft in Service:								
Jet	62	12	21	16	19 (8 leased)	15	15	15
Other	40	35	23	33	21	30	17	25
Average Length of Aircraft Flight	201	164	185	128	150	138	144	167
Total Number of Employees	7,600	3,301	3,400	3,123	2,681	3,038	2,009	2,304
Certificated Route Miles Operated-1970 ^(b)	7,559 ^(c)	8,509	6,494	6,750	4,895	3,623	5,145	5,830

*Results affected by labor dispute ending mid-April 1972.

a. Source - Public Benefits Provided by Local Airlines. Prepared by SARC for ALTA (1973).

b. Source - Handbook of Airline Statistics. CAB (1971).

c. Allegheny + Mohawk.

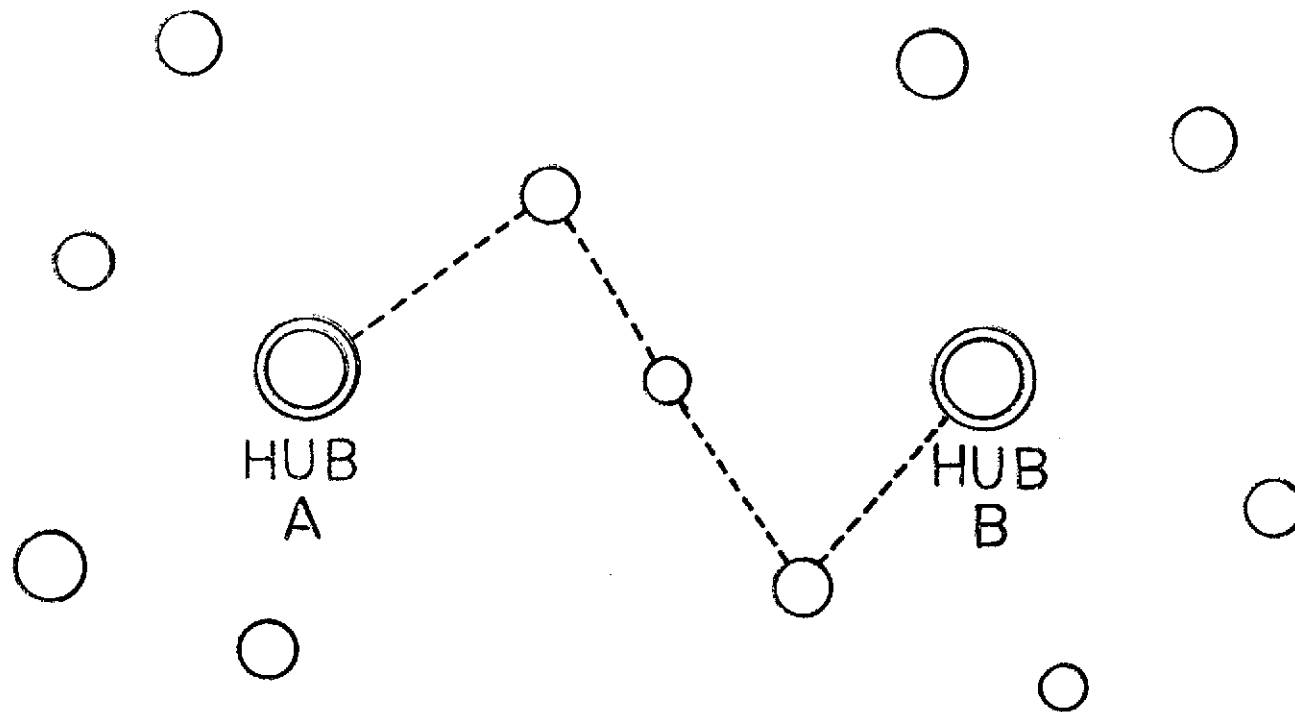
the carriers are in fact "mini-airlines", operating multi-aircraft fleets throughout regions several hundred miles square. At the other size extreme are the "mom and pop" operators with one or two aircraft serving a single market. Some commuters provide basic air service to small, isolated communities. Others offer air service as a convenience to travellers in dense population areas who want to save time getting to the airport for connecting flights. Operators in these dense markets already provide high frequency service and are now looking for aircraft in the 30 seat range to meet peak demand (particularly where airport slots may be limited). Other operators are looking toward the day their markets will support more than a few flights per day and they may be able to use 15 to 19 passenger aircraft like the bigger commuters.

Because of the diversity in both the local service and the commuter carriers, it is better to discuss problems in terms of route structures, the type of service offered and the types of markets served rather than characterize the problems by industry.

2.1 Route Structures

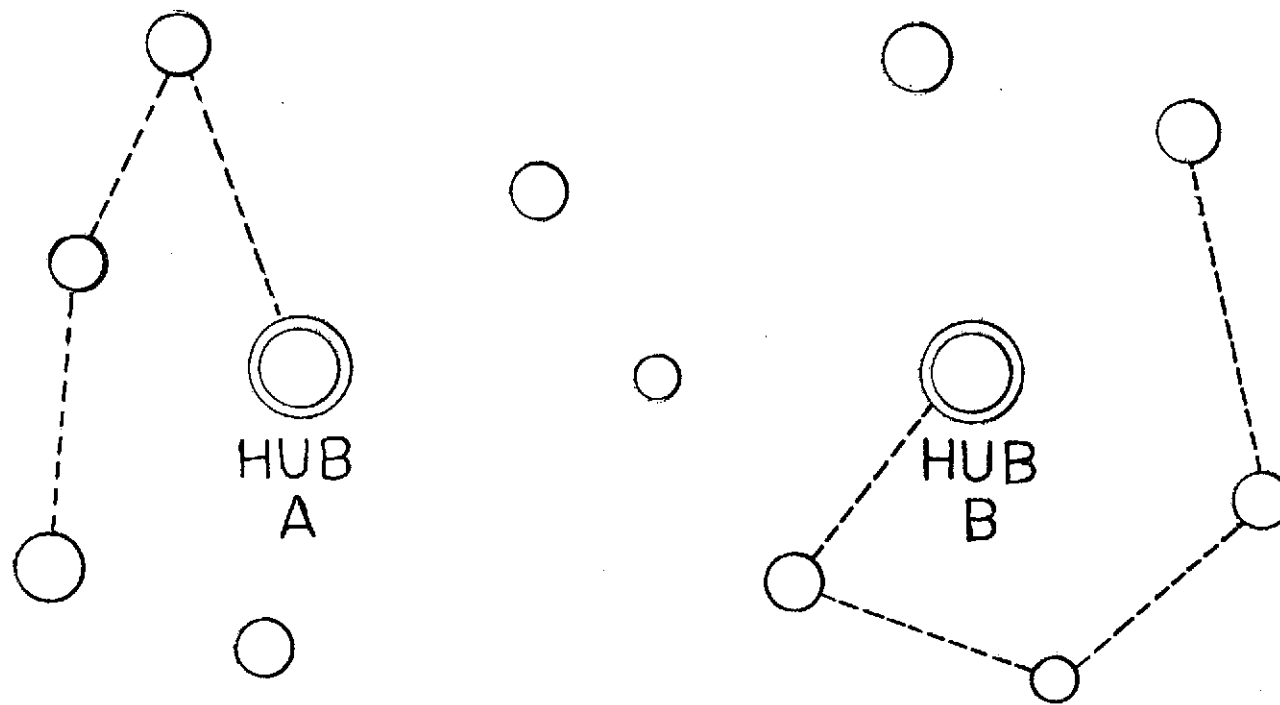
Ideally, an airline selects the aircraft best suited to its route structure. If there is no appropriate aircraft the airline will select the next best option. Once this non-optimal aircraft is in the fleet, however, the airline will try to modify its route structure to take advantage of the aircraft's specific characteristics. Thus route structure and aircraft type are intimately connected.

Several route structures can be identified. The classic route patterns of the local service industry are the hub-to-hub multistop and the multistop feeder patterns shown in figures 2.1 and 2.2. Although these patterns may seem similar, aircraft load factors differ greatly. In the hub-to-hub case, the aircraft leaves the first hub with a fairly high load. A number of these original passengers get off at the first stop, some at the next, and so on, until few if any get off at the destination hub. However, a few passengers for the destination hub may get on at the first stop. More board at the second and succeeding stops until the plane arrives at the destination. Since few passengers travel between the smaller cities by air, most are traveling to or from the smaller city and the hub at either end. Thus, although each stop may not produce many boardings or departures, the overall load-factor for any segment does not vary as much as might be anticipated.



HUB-TO-HUB MULTISTOP

FIGURE 2.1



MULTISTOP FEEDER SERVICE

FIGURE 2.2

In contrast, the multistop feeder flight does not accumulate passengers as passengers from the originating hub deplane. As a result, there may be high load factors for the segments near the hub but low load factors at the extremities. Figure 2.3 shows Frontier's flight 526. Between the major cities, it typifies hub-to-hub multistop operations. As it leaves Denver and wends its way into Montana, it becomes more typical of a multistop feeder flight.

Both of these two service patterns present an aircraft sizing problem. The plane must be able to accommodate the traffic on the peak segment. As a result, the aircraft is too large to economically serve less dense markets. It has been argued that the CAB's early policy of requiring local service carriers to provide multistop service, created this "segment flow" problem and is the primary reason that an economical, smaller aircraft has not been developed as a "DC3 replacement"⁽¹⁾. Whether this is true or not, the multistop route structure has determined the aircraft size.

With the acquisition of jet aircraft capable of serving longer haul markets, several of the local service carriers have developed route patterns defined as regional-bypass-to-distant-hub, (or bypass routes) as shown in Figure 2.4. Rather than feed traffic into the local hub and there lose it (or at best

1. Eads, George. The Search for an Efficient Short-Haul Aircraft: A Case Study in Conflicting Government Incentives. Distributed at M.I.T. Workshop on Low/Medium Density Air Transportation (1973).

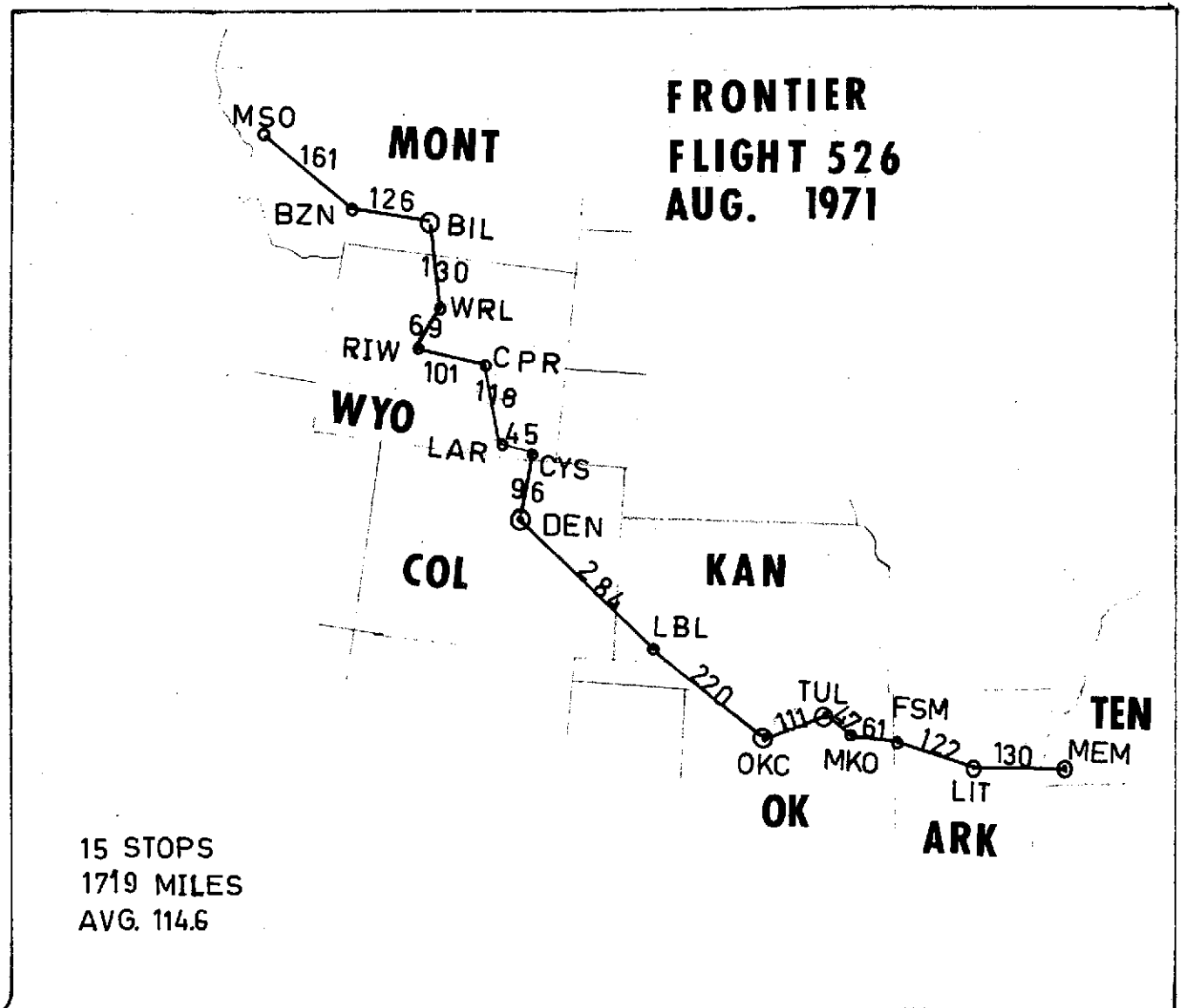
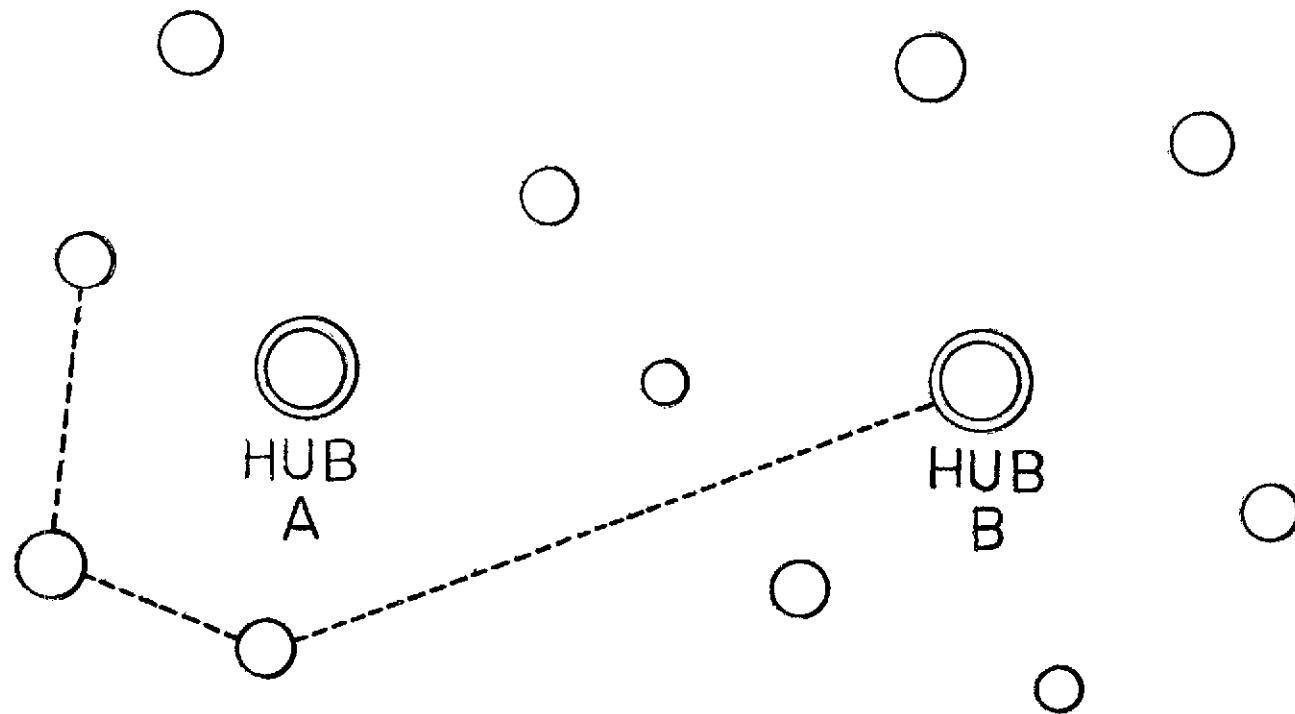


FIGURE 2.3

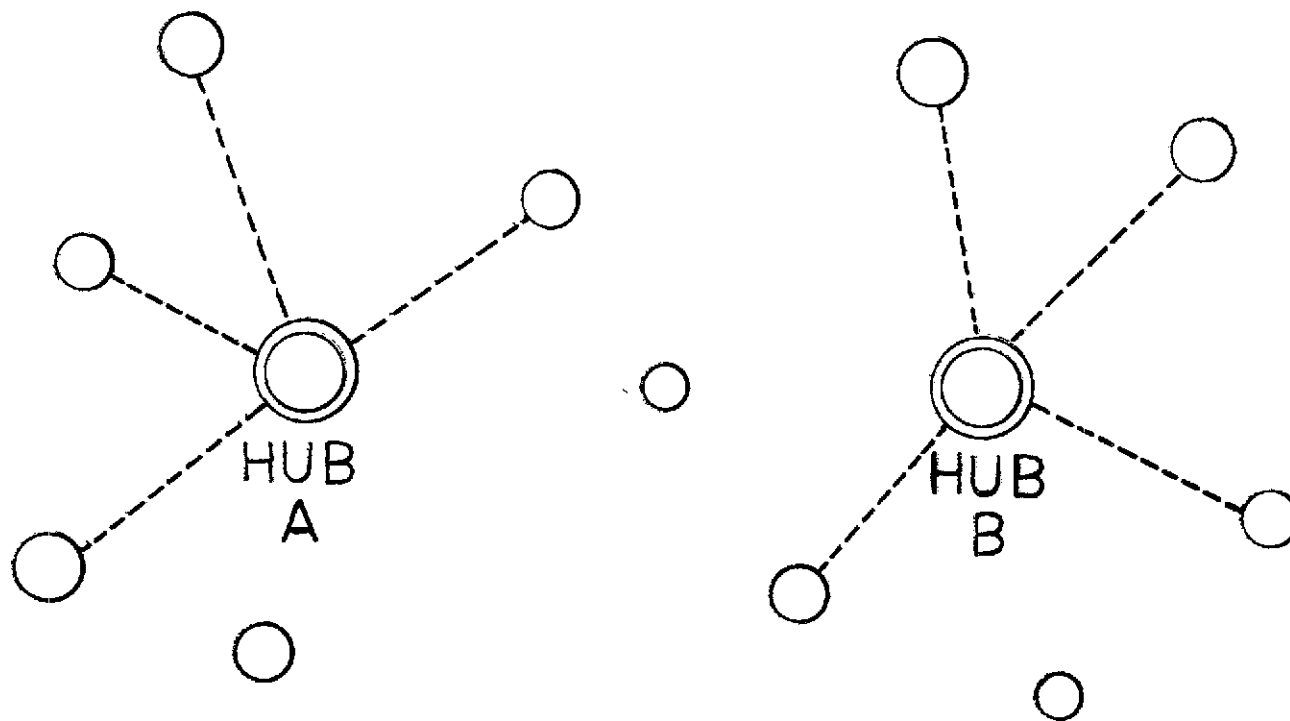


REGIONAL-BYPASS-TO-DISTANT-HUB

FIGURE 2.4

be forced to compete with a trunk carrier for the long haul flight to the distant hub), the local carrier makes one or two stops at smaller cities to accumulate passengers, and then flies directly to the destination, bypassing the regional hub. After acquiring DC9s, Southern revamped its entire service pattern to use this bypass concept where possible. This is an example of the aircraft shaping the route structure.

A final route structure, most often seen in commuter operations, is the hub-and-spoke pattern shown in figure 2.5. The carrier provides nonstop or at most one stop service from outlying areas directly to the hub. Since they do not face a segment flow problem, the commuters can size their aircraft for the specific run. Peak capacity is provided through scheduling additional sections.



HUB-AND-SPOKE FEEDER

FIGURE 2.5

2.2 Types of Service

There are two basic types of air service. The first is origin-destination service where the traveller both starts and completes his trip on one flight. The second is connecting service. The passenger is transferred from his community to the regional hub where he connects with a long haul flight (usually of a trunk airline) to his destination.

Many commuter airlines have been created specifically to serve this connecting traffic market, particularly in high density areas surrounding major hubs. In these areas, the carrier is competing with the automobile, the principal mode of airport access. To compete effectively, total trip time and cost must be competitive with the car. Therefore, the carriers have tailored their service to meet the connecting passenger's needs. Flights are timed to match the long haul departure and arrival patterns at the hub airport. Service is frequent throughout the day in order to reduce waiting time at the hub.

To compete on a cost basis, the commuter may offer free or reduced rate parking at the local airport. Joint and through fare agreements with the certificated carrier are also used to lower traveller costs. The passenger pays a small portion, if any, of the normal commuter fare. The remainder is reimbursed to the commuter by the certificated carrier from the long haul revenues. By offering the package, the certificated carrier can

capture more of the long haul traffic than another certificated carrier who does not participate in a joint or through fare arrangement. The commuter carries more traffic and the traveller receives better service for about the same cost.

Commuter carriers serving the low or medium density markets face a different problem. A higher percentage of their traffic is origin-destination; people from the small community going into the hub for personal or business reasons. This dictates a different service pattern. The origin-destination passenger would like to leave the outlying community in the morning and return in the evening. There is high demand during these periods, but much less during the rest of the day. As a result, aircraft utilization is low unless the carrier can develop off-hour markets. Cargo and mail contracts provide offsetting loads in many cases. In other markets, the carrier may try to provide connecting service in a shorter haul market using his idle aircraft to provide frequency. In any case, the resulting service pattern will not be the same as for high density feeder operations.

Since a commuter carrier usually specializes in either high density hub and spoke feeder operations or low density service, he can tailor his service patterns, routes and aircraft for one market or the other. In contrast, the local service carrier must serve both types of markets simultaneously. Figure 2.6 indicates the mix of connecting and origin-destination traffic for markets

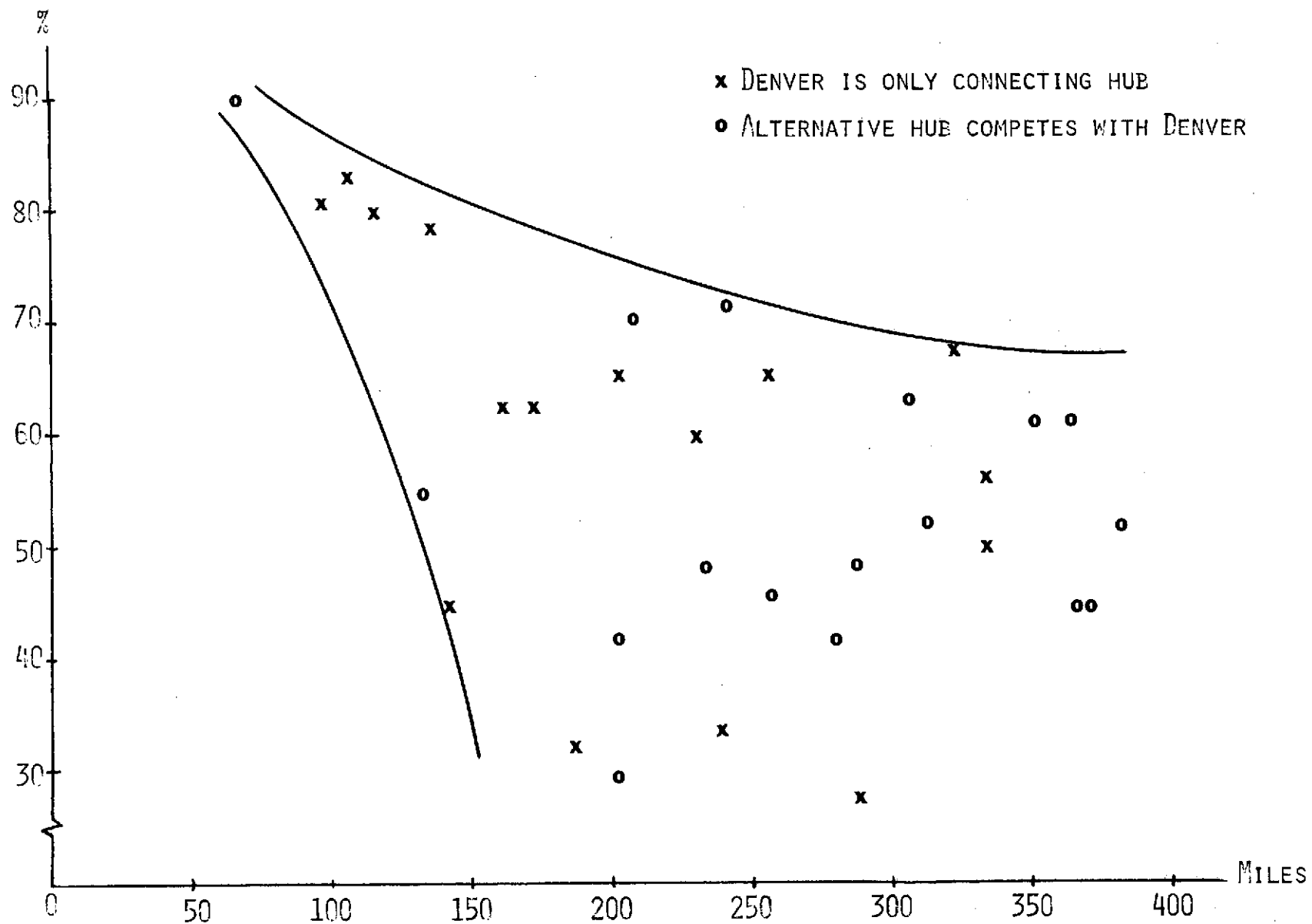


FIGURE 2.6

DISTRIBUTION OF % CONNECTING PASSENGERS VS TRIP LENGTH
FRONTIER'S SERVICE TO DENVER

SOURCE: CAB O-D SURVEY OF AIRLINE PASSENGER TRAFFIC - VOL. IV-4-7, 4TH QUARTER, 1971

into Denver served by Frontier. Using CAB data, the percentage of passengers connecting at Denver was plotted against distance for all small cities served by Frontier within approximately 400 miles of Denver. As might be expected, cities closer in provided a higher percentage of connecting passengers, while more people further out made Denver their destination. This is probably because people closer to the hub are more likely to drive into town for personal or business reason than people several hundred miles away. Also, as might be expected, there is a lower percentage of connecting passengers on flights into Denver from communities that have air service to other connection points. The connecting passengers from the small town are thus spread among several hubs leaving a higher percentage of passengers with Denver as their ultimate destination.

Because of the segment flow problem discussed earlier, the local carriers use fairly large aircraft, at least compared to commuters. Since these aircraft cost more per mile to operate than a commuter aircraft, a local is not able to provide as high a frequency in a connecting market as a commuter carrier using smaller planes. Likewise, a local must generate more passengers than a commuter to break even at low density points.

Through the use of through and joint fares, the local can offer some of the same economic incentives as the commuters for connecting passenger. Likewise, the benefits of reduced parking

rates can also induce connecting passengers to use the local carrier instead of driving. Unlike the commuter, however, the local carrier cannot tailor his service to connecting or origin-destination traffic since he must serve both types of markets at the same time. He must strike some compromise.

To maximize their revenues under this complex situation, many locals have developed an effective strategy. Profitable markets receive excellent service. Aircraft are used at prime hours and with sufficient frequency to maximize passenger satisfaction, thus maximizing passenger revenues. The low density markets that don't support themselves receive the minimum service needed to entitle the carrier to subsidy. Since the CAB does not specify when subsidized service is to be rendered, the carrier fits its schedule around available aircraft, often at off peak hours, to serve the low density points. This minimizes the cost of serving these markets, maximizing the revenues derived from subsidy.

The resulting multistop or off-hour flights do not satisfy the needs of these markets. There is not enough frequency to satisfy the connecting passenger, and the times of arrival and departure are not tailored to one day round trips to the nearest air hub. However, it is probably the best service available under the regulatory circumstances. Many of the local service carriers have a real interest in serving the markets they were

created to serve. But if they were to change their service patterns, they would lose more revenue from their better markets than they would gain from subsidized points. The resulting overall loss would increase overall system subsidy requirements and eventually lead to general decay of service to all points.

2.3 Market Structure

Markets can be defined in terms of the number of passengers generated, the length of haul and the degree of isolation from other cities or transportation hubs. The first and second elements of this definition indicate the economic condition of the market. The first and third elements reflect the public benefit provided by the service.

In addressing the problem of market definition in the past, rather mechanical approaches have been taken. For example, the Civil Aeronautics Board, under its "use it or lose" policy, would allow a petition by a carrier to delete communities boarding 5 or less people per day from the carrier's certificate, unless unusual circumstances could be shown.⁽²⁾ In the 1971 Bureau of Operating Rights' study on service to small communities⁽³⁾, a test based on both the number of boardings and the degree of isolation was proposed. The degree of isolation was measured on a sliding scale that factored in both the length of drive to the nearest air hub and the service level at the hub.

This type of mechanical test offers computational ease, but raises the issue of where the limits should be set. Since the decision must, by its nature, be somewhat arbitrary, the limits will be too severe in some markets and too lax in others. However, the mechanical test is useful in establishing a baseline or starting

2. Seven State Area Investigation. 28 C.A.B. 680 (1958)

3. Bureau of Operating Rights. Service to Small Communities. Civil Aeronautics Board (March, 1972).

point for regulatory policy and procedures.

In a study of aircraft requirements, a different definition is needed. Since the aircraft will be selected on the basis of economic performance, an economic market definition has been selected.

For a given fare and cost structure, the economics of a given market are determined by the number of passengers boarded and the length of haul. With this in mind, a low density market is defined as one in which a carrier's revenues, excluding subsidies, do not meet its expenses, while a medium density market is defined as one in which the carrier can at least break even. A carrier can convert a low density market into a medium density market by either raising the revenues generated or by lowering expenses. Conversely, a medium density market can erode into a low density market if revenues fall or expenses increase.

To decide whether revenues cover expenses, one must consider the impact of the particular market segment on the total system, and not examine it on its own merits alone. Often the people boarded at a small community will connect to a more profitable long haul flight on the same airline. Thus a carrier that captures a high percentage of its small town traffic for longer haul flights will continue to serve a low density point even without external subsidy.

Revenues can be increased by either raising fares or by increasing passengers. Depending on the fare elasticity in the market, a fare increase might actually decrease overall revenue, and so must be considered with caution. To generate more passengers, improved service and/or advertising may be required. But this could increase expenses which might offset any revenue gains, particularly if only a few additional passengers are boarded.

Expenses can be lowered in many ways. The most common has been to reduce the level of service. In general, this has resulted in fewer passengers as people substitute their automobiles for infrequent or inconvenient flights.

Since most local service and commuter carriers have limited capital, the response in low density markets has been to minimize expenses rather than maximizing revenues. They are rarely willing to gamble on revenue increases resulting from fare cuts or service increases. The result has been a decline or actual deletion of service to points that might have the potential of supporting air travel if service were improved.

What is a low density point to one carrier could be a medium density market for another. Commuters, with their lower cost structure, can serve points profitably that would require a subsidy for a local service carrier. However, there are some markets that cannot support regularly scheduled air service by

any type of carrier. These can be defined as very low density markets and would be most economically served by on-demand air taxi operators, if at all.

The degree of isolation is not an economic factor, but a political issue. It has little bearing on the type of aircraft used to provide service, but rather relates to whether there should be service at all. This public service aspect of air transportation was recognized by the CAB during the early 1940's and was a major factor in starting the Local Service Experiment.⁽⁴⁾

As with low and medium density, the degree of isolation escapes precise definition. As mentioned, the CAB Bureau of Operating Rights' report on service to small communities recommended a test based on the driving time to the nearest air hub and the level of service at that hub. No community within 90 driving minutes of any hub was considered isolated. If the hub were a major one, no community within a two hour drive was considered isolated.

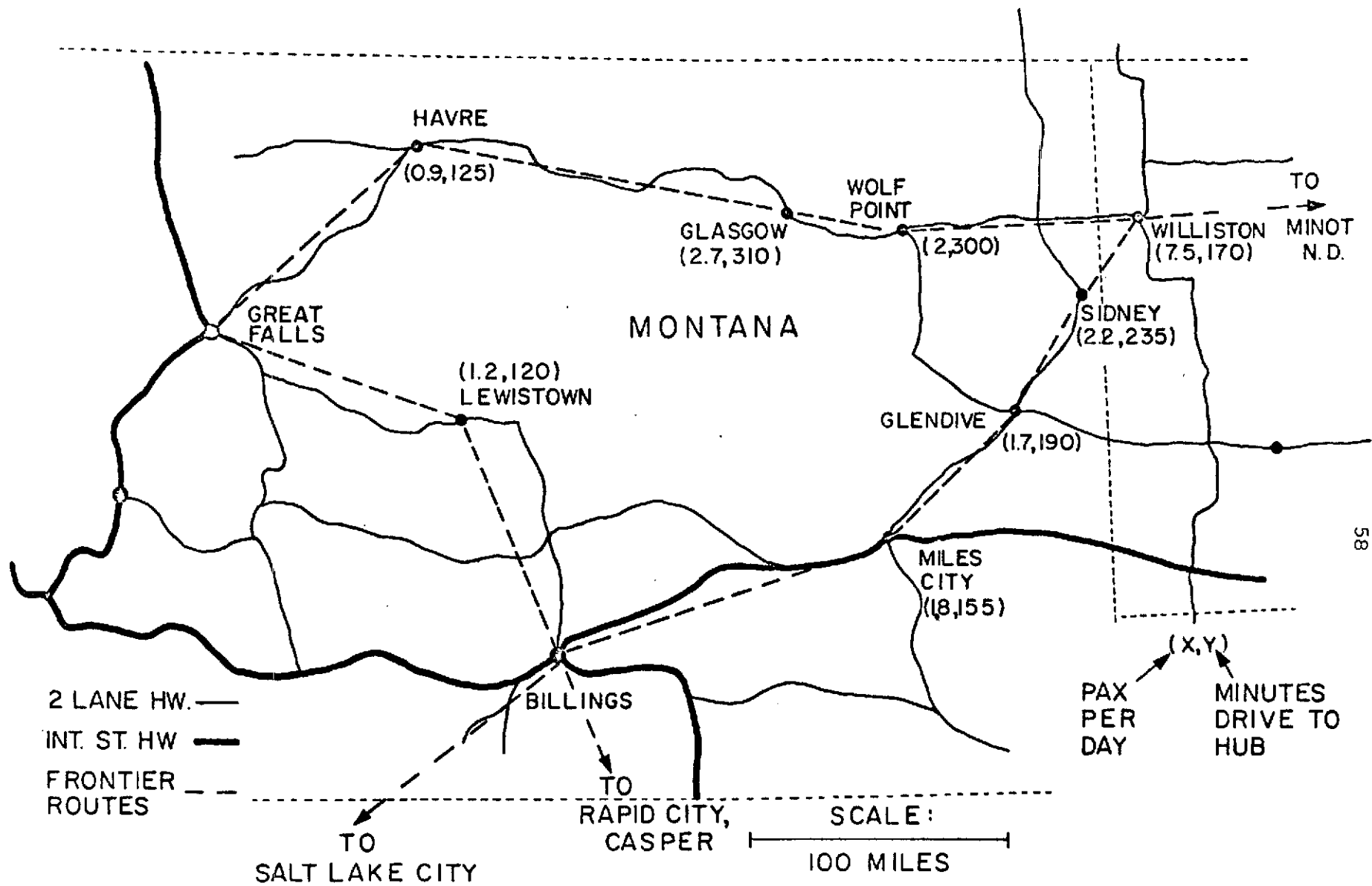
Since aircraft requirements do not depend on the degree of isolation, a less precise definition has been adopted for this study. A market is not considered isolated as long as the automobile is an effective competing mode. A market is isolated when the bulk of the intercity traffic goes either by air, or not at all.

4. Investigation of Local, Feeder, and Pick-Up Service. 6 CAB 1 (1944).

Figure 2.7 is an example of a low density, isolated market. An actual portion of the Frontier route structure is shown. The numbers in parenthesis represent the average number of passengers boarded per day and the driving time to the nearest air hub in minutes for each city served. Most of these are actually very low density markets. There are few highways much less interstate freeways connecting the towns.

In contrast, the Southern Airways system reproduced in Figure 2.8 provides service to low density but non-isolated points. Interstate highways parallel many of the routes so the automobile is a very convenient alternative to air service.

Another type of market was specifically identified with typical commuter operations. This is the high density feeder market primarily providing airport access from communities surrounding major air hubs. Operators in these markets face different problems than those in low or medium density areas. They provide high frequency, very short haul service with resultant high wear from frequent takeoffs and landings. Economically, the major problems are a high degree of peaking and directionality in their traffic flow and automobile competition. Faced with many empty backhauls, it is difficult to get the system load factor over 50%. Figure 2.9, typical of a high density feeder market, shows Golden Wests' route system in the Los Angeles area.



LOW DENSITY, ISOLATED MARKET

FIGURE 2.7

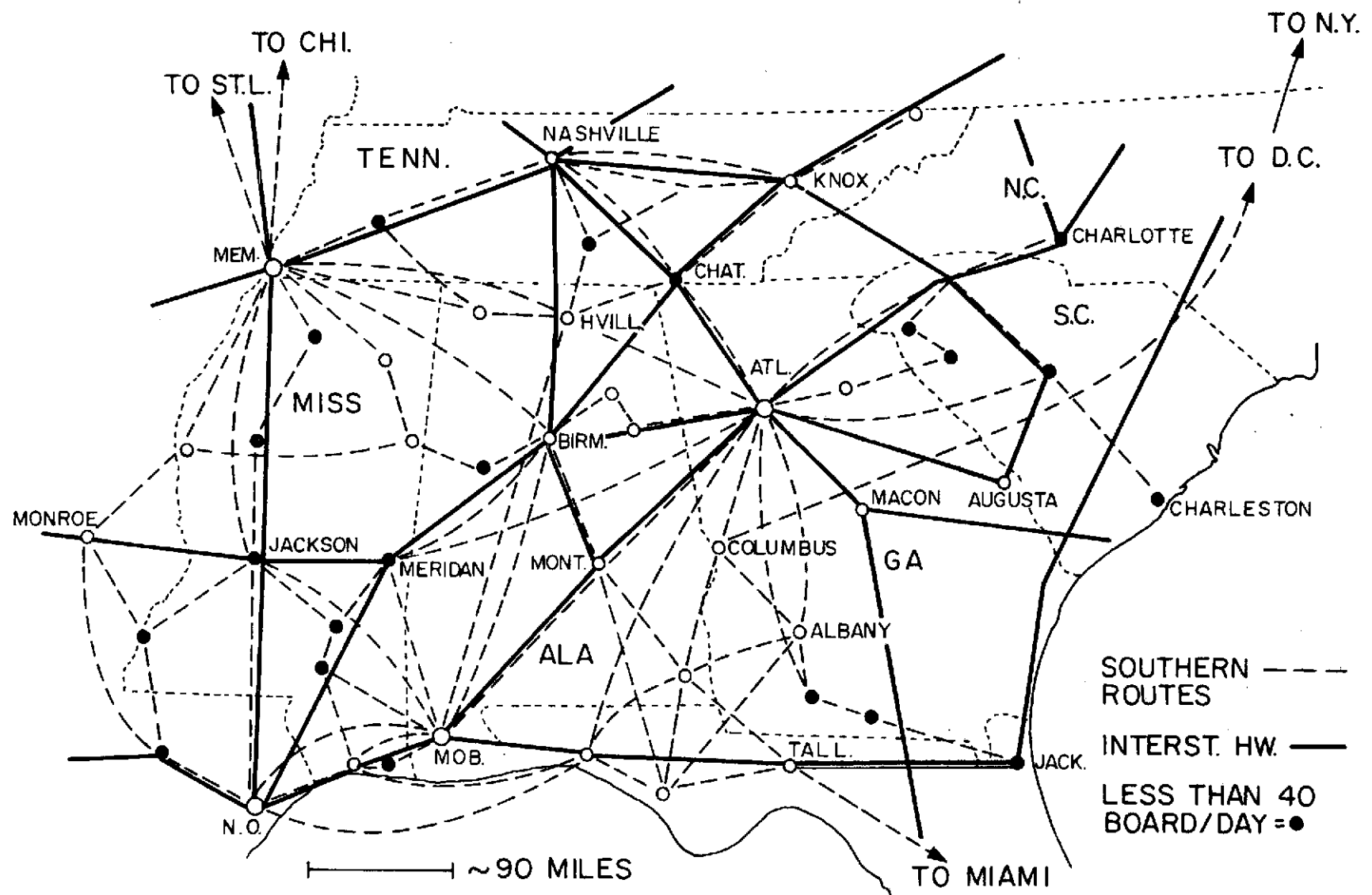
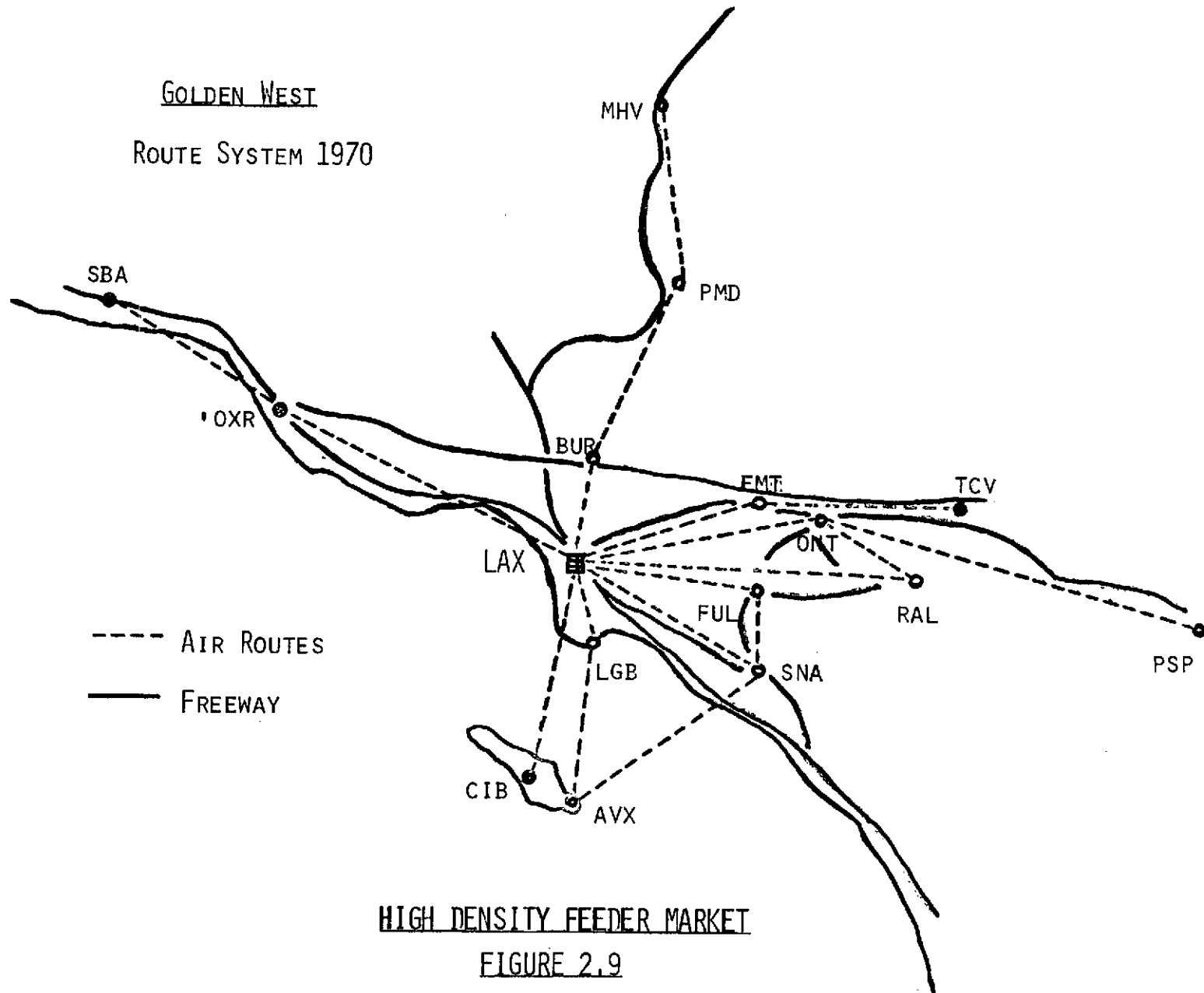


FIGURE 2.8
LOW DENSITY, NON-ISOLATED MARKET

GOLDEN WEST
ROUTE SYSTEM 1970



HIGH DENSITY FEEDER MARKET
FIGURE 2.9

A final type of market is created by geographic considerations, taking special advantage of the aircrafts' ability to fly over water or mountainous terrain. Automobile travel, if available at all, is circuitous and time consuming. Figure 2.10 shows Wright Airline's service across Lake Erie and the highway alternatives. Other examples are Aspen and Rocky Mountain Airlines' service to mountain ski resorts and the many carriers serving the islands of the West Indies.

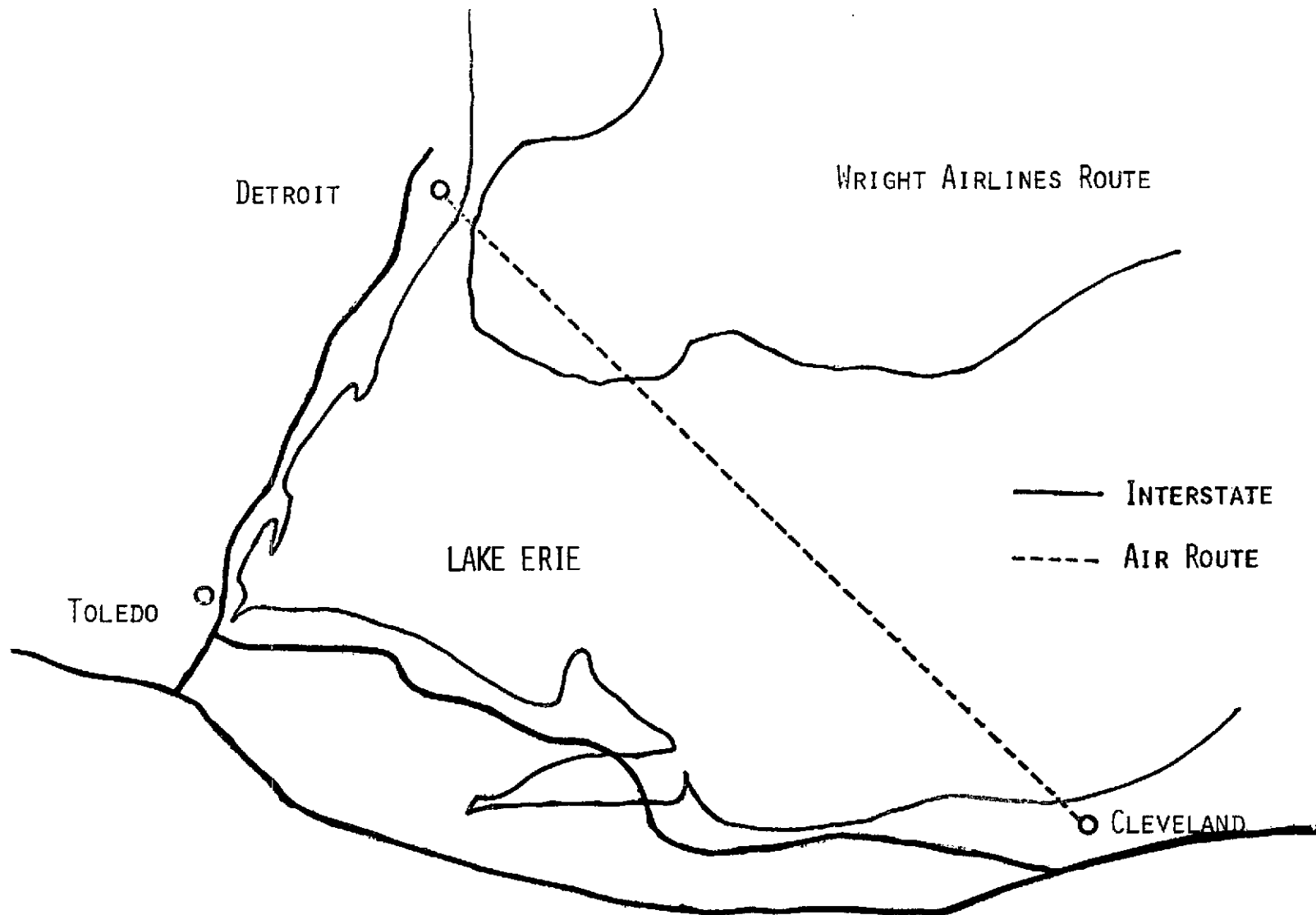


FIGURE 2.10
SPECIAL MARKET

3. AIRCRAFT ANALYSIS

This section of the report addresses the basic issues related to aircraft in the low/medium density area. The first part is concerned with aircraft pricing; the second provides a comparison of aircraft suitable for this area; the third discusses briefly the possible world wide market for new aircraft configured for 20 to 60 passengers.

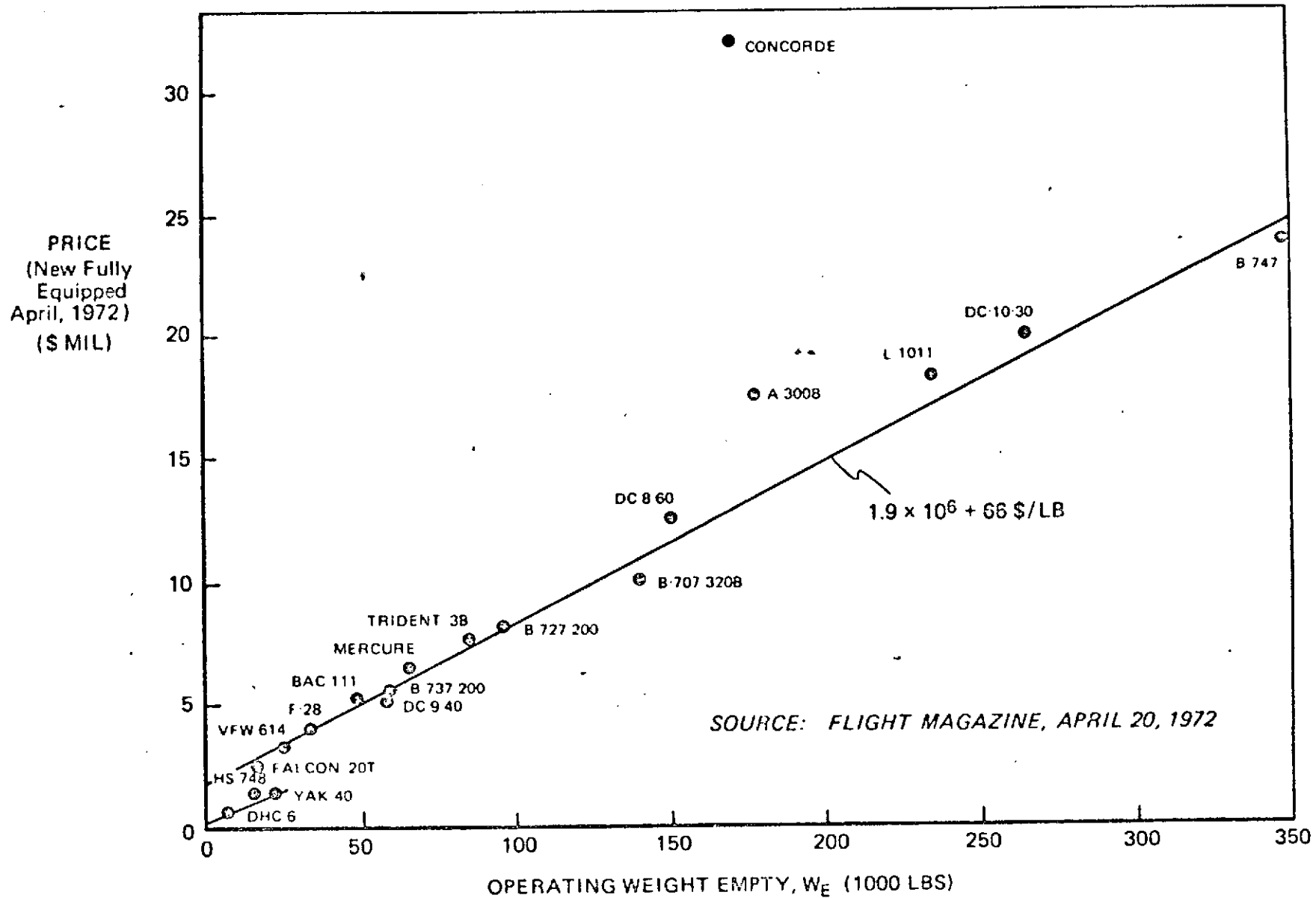
3.1 The Price of Transport Aircraft

The price of a new airplane is clearly one of the critical factors in determining the aircraft type in the low/medium density area served by local service airlines and commuter air carriers. This section presents an approximate method to rapidly calculate the cost, and consequently the price, of new subsonic transport aircraft. (In this discussion all dollars are 1972 dollars.)

The price which is set by a manufacturer for a new aircraft is a function of the prices of similar aircraft on the market, the share of the overall market he expects to obtain, and his costs of manufacturing the vehicle. In defining a price, he establishes a breakeven production run size; ie. he expects to sell at least this number of aircraft over a predetermined period of time. Figure 3.1 shows the price of current transport aircraft plotted against operating weight empty. At the lower end of aircraft (those of less than 50,000lbs) and of primary interest for the low/medium density markets there is considerable scatter. In this spectrum there are small and larger turboprops (DHC-6 and HS748) and government-built airplanes (YAK-40), as well as conventional

FIGURE 3.1

THE PRICE OF CURRENT TRANSPORT AIRCRAFT



jet aircraft.

Manufacturing costs of new aircraft can be divided into "development" costs and "production" costs. Development costs are the non-recurring costs of designing, testing, and certifying a new transport aircraft. Production costs are those incurred in establishing and running a production line for building essentially similar aircraft.

Airplane development costs vary with the complexity of the aircraft. However, a rough estimate can be based upon historical development costs and a relationship to empty weight less engines of the vehicle. For subsonic aircraft, development costs are approximately \$3,000/lb. Thus, for the B727-200, the development costs are assumed to be \$300 million, the B747 \$1,200 million, and for a hypothetical new 40 passenger subsonic aircraft (empty weight of 20,000 lbs.), the US-40, the development costs should be approximately \$60 million. Since inflation is a fact of life, development costs also change over time. Depending on when development of a new 40 passenger plane takes place, a higher price per lb. may be indicated.

Breaking the development costs down as a cost per airplane, it becomes immediately obvious that the development cost per unit depends very strongly on the size of the production run, n . For the US-40, the unit development cost for a production run of 50 would be \$1.2 million; for 500 \$0.12 million. Figure

3.2 shows this strong dependence. Thus a run size of at least 200 would be required to reduce the development cost aspect of the overall cost figure. The potential size of the market for the aircraft thereby becomes an important variable in predicting total airplane costs and consequently complete airplane price.

The recurring production costs also vary with the number of aircraft produced, although the reduction due to quantity is not as pronounced. This reduction occurs because of a well-established "learning process" which takes place on large scale production runs. The cost of the n^{th} airplane, $C(n)$, on a production line can be expressed as a function of the cost of the first airplane, $C(1)$, plus a learning variable, p , in the following form:

$$C(n) = C(1)n^{-p} \quad (3.1)$$

A learning variable of $p = 0.23$ corresponds to a 85% learning curve, where doubling the run size reduces costs to 85% of their initial value. This is a reasonable value for such a complex item as an airplane. An average production cost per airplane is:

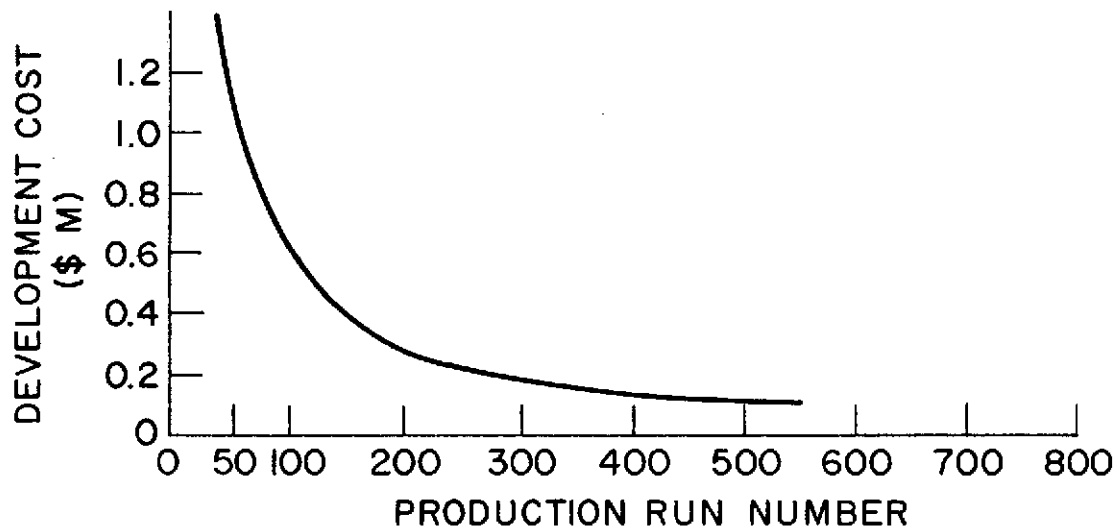
$$C_{av} = \frac{C(1)n^{-p}}{1-p} \quad (3.2)$$

The cost of the initial airplane can also be roughly estimated at \$200/lb. of empty weight (resulting in an initial production cost of \$4million for the Us-40). Again, depending at what point in time production would begin, the initial cost would also be higher due to inflationary factors. Thus the average production cost of a new subsonic aircraft is estimated as:

FIGURE 3.2

COST OF NEW AIRCRAFT

- PER AIRCRAFT: FUNCTION OF PRODUCTION RUN



$$C_{av} = \frac{200n^{-.23}}{0.77} \quad (3.3)$$

The "price" of engines is assumed to be \$25/lb. of static thrust (T_o). The engine price is assumed to be independent of airframe production size. The \$25/lb. figure assumes that the engines used have their own production line and will be used on more than one vehicle. Thus engine costs are:

$$C_e = 25 N_e T_o \quad (3.4)$$

where N_e is the number of engines used on the aircraft.

The total average aircraft cost is thus summarized as Equation (3.5).

$$C_{ac} = \left(\frac{3000}{n} + \frac{200n^{-0.23}}{0.77} \right) W_e + 25 N_e T_o \quad (3.5)$$

where W_e is basic operating weight empty less engines of the aircraft.

For an example, a US-40 design, the following parameters would apply:

$$\begin{aligned} W_e &= 20,000 \text{ lbs.} \\ T_o &= 8,000 \text{ lbs.} \quad N_e = 2 \\ \text{for } n &= 200 \\ C_{ac} &= \$ 2.3 \text{ million} \end{aligned}$$

To allow for some return on investment, the US - 40 could be priced at \$2.5 million. At this price, it would be competitive with the Falcon 30.

To show the effect of government funded development, Table 3.1 presents the range of total aircraft costs for different assumed development costs and different production quantities. It is apparent that government development (zero assumed development cost) of this type of aircraft makes a substantial impact on cost

TABLE 3.1

SUMMARY OF AIRCRAFT COST
(TWIN 40 PAX JET)

NO. OF AIRCRAFT IN PRODUCTION RUN

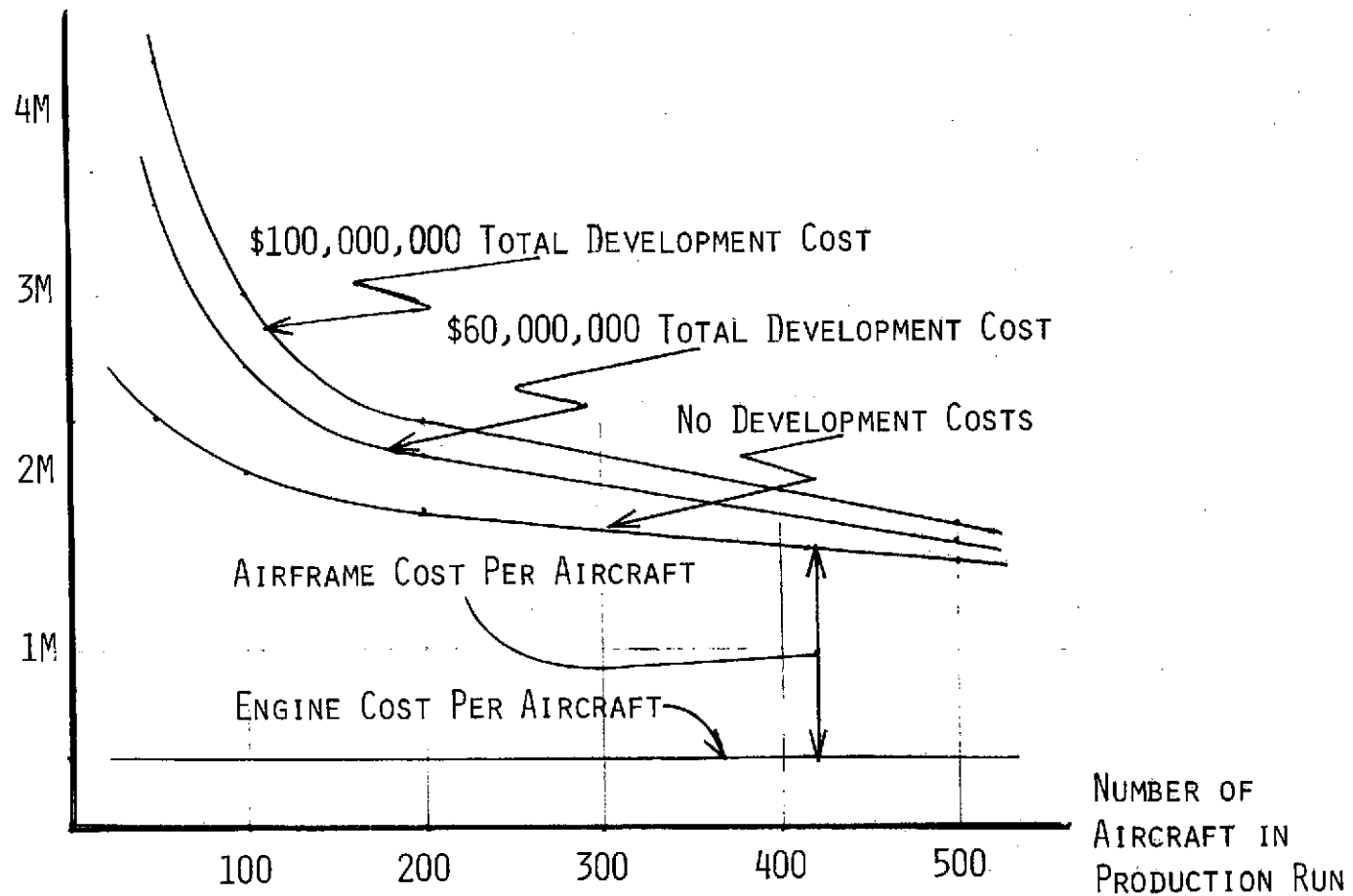
ASSUMED
DEVELOPMENT
COST
(\$ m)

	50	100	200	500
0	2.58	2.27	2.00	1.70
60	3.78	2.87	2.30	1.82
100	4.58	3.27	2.50	1.90

when the production run is assumed to be small. If the market is foreseen to be 200 aircraft or more, the development costs are no longer critical. A graphical presentation of the same information for a 30 passenger twin engine plane is shown in Figure 3.3.

FIGURE 3.3

COST PER AIRCRAFT
\$



US-30 COST PER AIRCRAFT

AS A FUNCTION OF:

1. SIZE OF PRODUCTION RUN,
2. DEVELOPMENT COSTS

3.2 Aircraft Comparison

The material in this section is intended to provide a convenient comparison of different aircraft suitable for service in the low/medium density areas. Both existing and proposed aircraft are shown. The list of aircraft presented is not all inclusive; however the range of planes in terms of passenger configurations is from 20 to 60, and thus the list is fairly representative of available aircraft.

The three major areas of comparison are performance (Tables 3.2,3.4), range-payload (Figures 3.4,3.7), and economic (Tables 3.3,3.5; Figures 3.5,3.6,3.8,3.9). The economic comparison is based on the ATA 1967 "Standard Method of Estimating Comparative Direct Operating Costs of Turbine Powered Transport Airplanes" assuming 2500 hour annual utilization, a 12 year depreciation period, and a \$4.00 per hour maintenance labor rate. The ATA formula is designed to provide a basis of comparison between differing types of airplanes and should not be considered a reliable assessment of the actual true value of the operating costs experienced on a given airplane.

Some of the other terms used in this comparison are:

Passenger Capacity - Most of the aircraft are offered in several seating configurations. The numbers shown in the passenger capacity figure reflect this fact.

Maximum Takeoff Weight - Includes the aircraft operating empty weight, the fuel weight, and the payload.

Maximum Cruise Speed - The maximum cruise speed for the aircraft at an altitude of 15,000 feet. The value is given in

statute miles per hour.

Takeoff Distance Required - This value is the approximate runway length required to satisfy FAR Part 25, at sea level and ISA +15°C, for the aircraft with maximum payload and fuel for a 300 mile trip not including reserves.

Range with Maximum Payload - The distance in statute miles that the aircraft can fly with maximum payload, excluding reserve fuel.

\$/BlockHour - Computed for a stage length of 100 miles.

\$/Available Seat Mile - Computed for a stage length of 100 miles.

Cost per Aircraft Trip - Cost per Seat Trip - These values are given in the form $C_1 + C_2 d$ where C_1 is a constant unrelated to trip distance (d), and C_2 is the mileage rate.

The aircraft prices used in the economic comparison are as follows (in 1972 dollars):

Convair 580 (used)	:	\$ 250,000
DHC - 6 (new)	:	680,000
Swearingen Metro	:	705,000
Nord 262 (new)	:	1,000,000
YAK 40 (new)	:	1,100,000
F 27 (new)	:	1,360,000
F 27-500/FH 227 (new)	:	1,600,000
HS 748 (new)	:	1,600,000
DHC - 7	:	2,300,000
Falcon 30	:	2,500,000
US - 40	:	2,500,000
VFW 614	:	3,000,000

Of the smaller aircraft, the Swearingen Metro appears to be

TABLE 3.2

PERFORMANCE COMPARISON

	DHC- 6	METRO	NORD 262	YAK 40	FALCON 30	VFW 614	DHC- 7
PASSENGER CAPACITY	18-20	20	26-29	27-40	29-38	40-44	48
MAXIMUM TAKEOFF WEIGHT (lb.)	12,500	12,500	23,370	36,067	32,410	41,000	41,000
MAXIMUM CRUISE SPEED (mph)	210	300	260	311	495	415	267 ⁷⁴
TAKEOFF DISTANCE REQUIRED (ft.)	1,500	2,800	3,600	3,280	4,550	3,950	2,000
RANGE WITH MAXIMUM PAYLOAD (mi.)	70	200	1,490	375	325	325	700

FIGURE 3.4

RANGE PAYLOAD DIAGRAMS

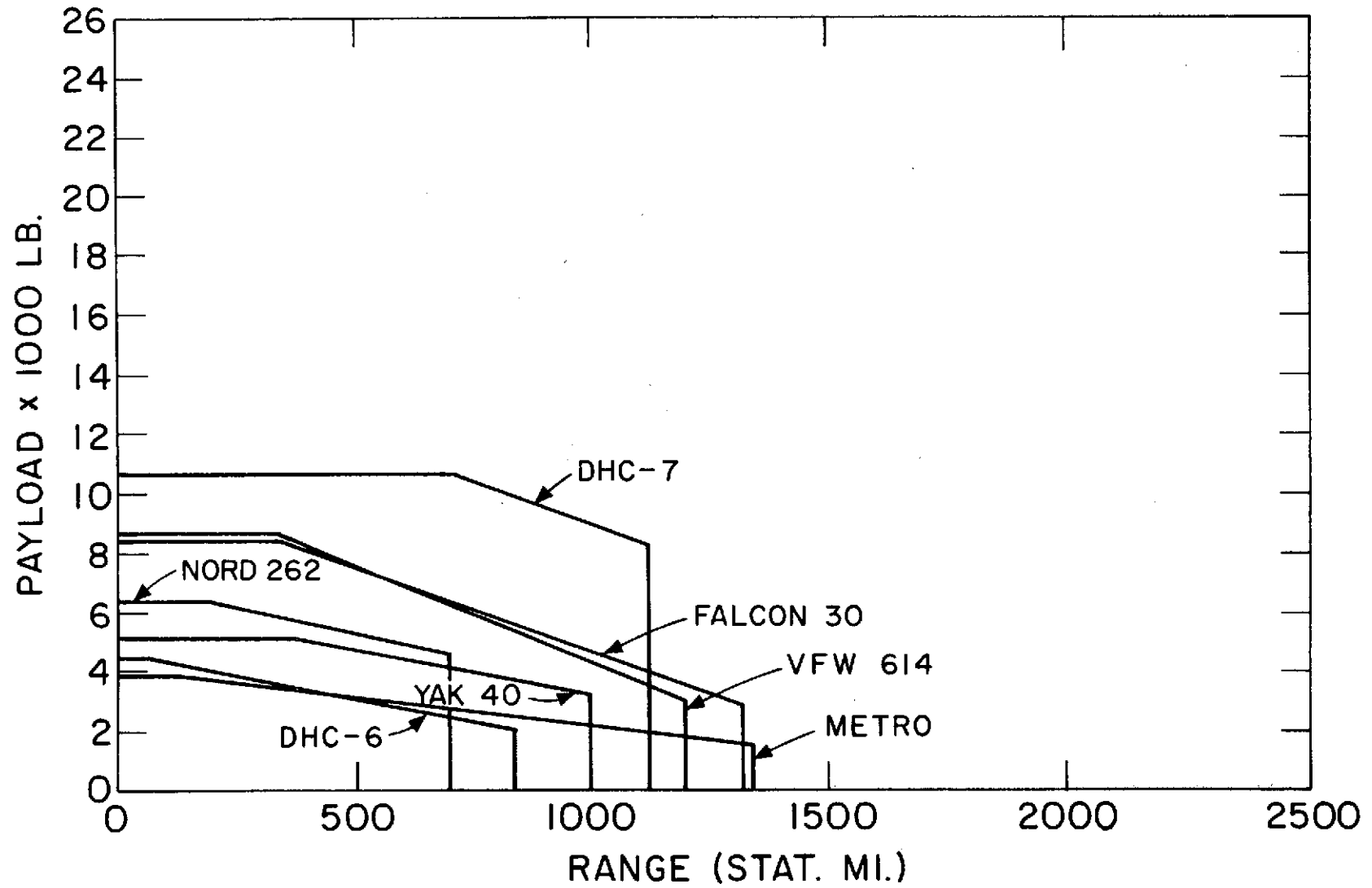


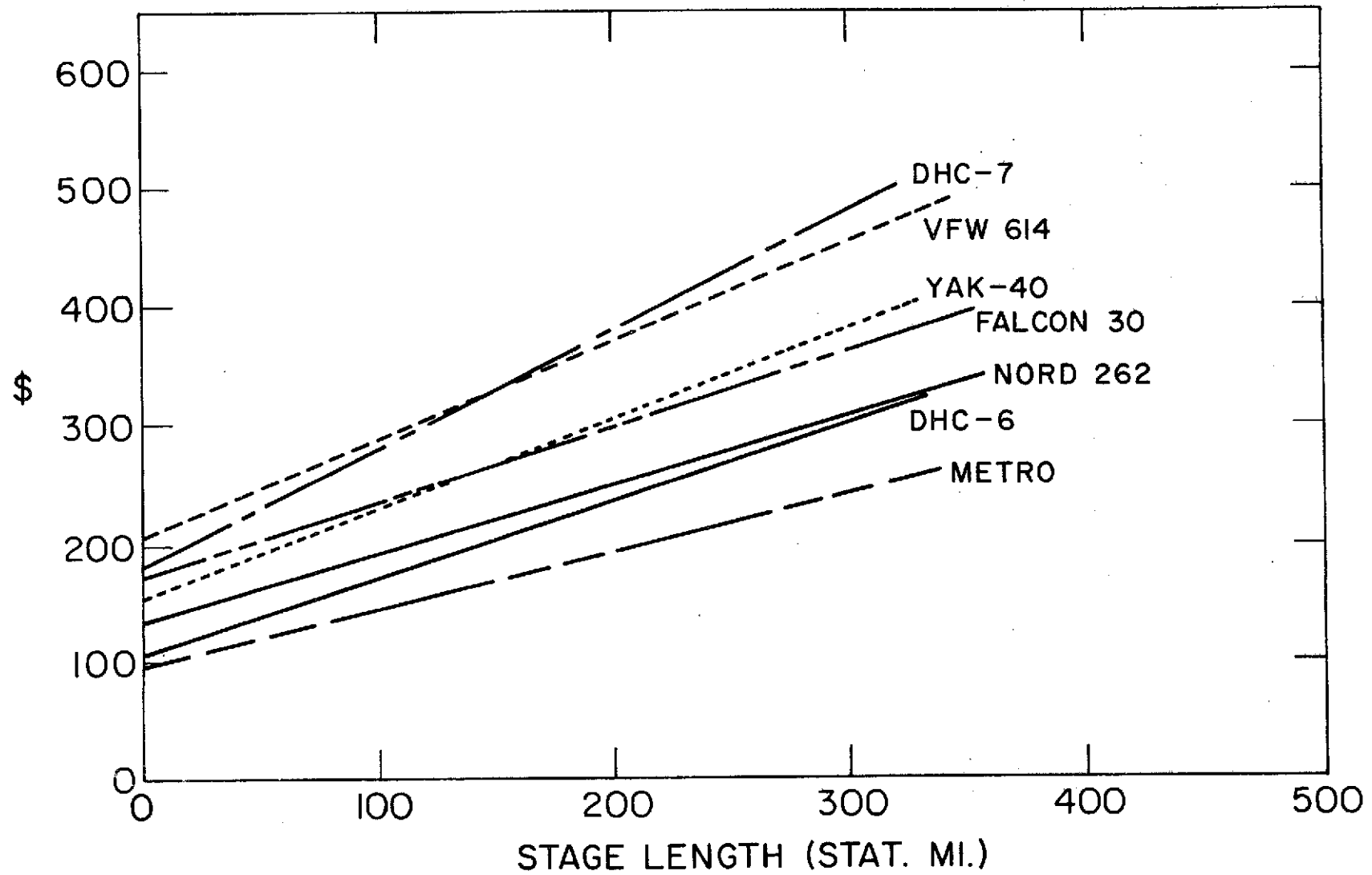
TABLE 3.3

ECONOMIC COMPARISON

	DHC-6	METRO	NORD 262	YAK 40	FALCON 30	VFW 614	DHC-7
\$/BLOCK HR.	154.1	156.7	188.6	260.3	362.3	410.0	313.8
\$/AVAILABLE SEAT MILE	0.085	0.071	0.065	0.058	0.062	0.065	0.059 ⁷⁶
COST PER AIRCRAFT TRIP (\$)	104.45+ 0.66/mi.	95.92+ 0.46/mi.	130.61+ 0.59/mi.	155.87+ 0.76/mi.	173.87+ 0.63/mi.	203.81+ 0.84/mi.	181.26+ 1.00/mi.
COST PER SEAT TRIP (\$)	5.22+ 0.033/mi.	480.+ 0.0228/mi.	4.50+ 0.0204/mi.	3.90+ 0.019/mi.	4.58+ 0.017/mi.	4.63+ 0.019/mi.	3.78+ 0.021/mi.

FIGURE 3.5

COST PER AIRCRAFT TRIP



78
FIGURE 3.6

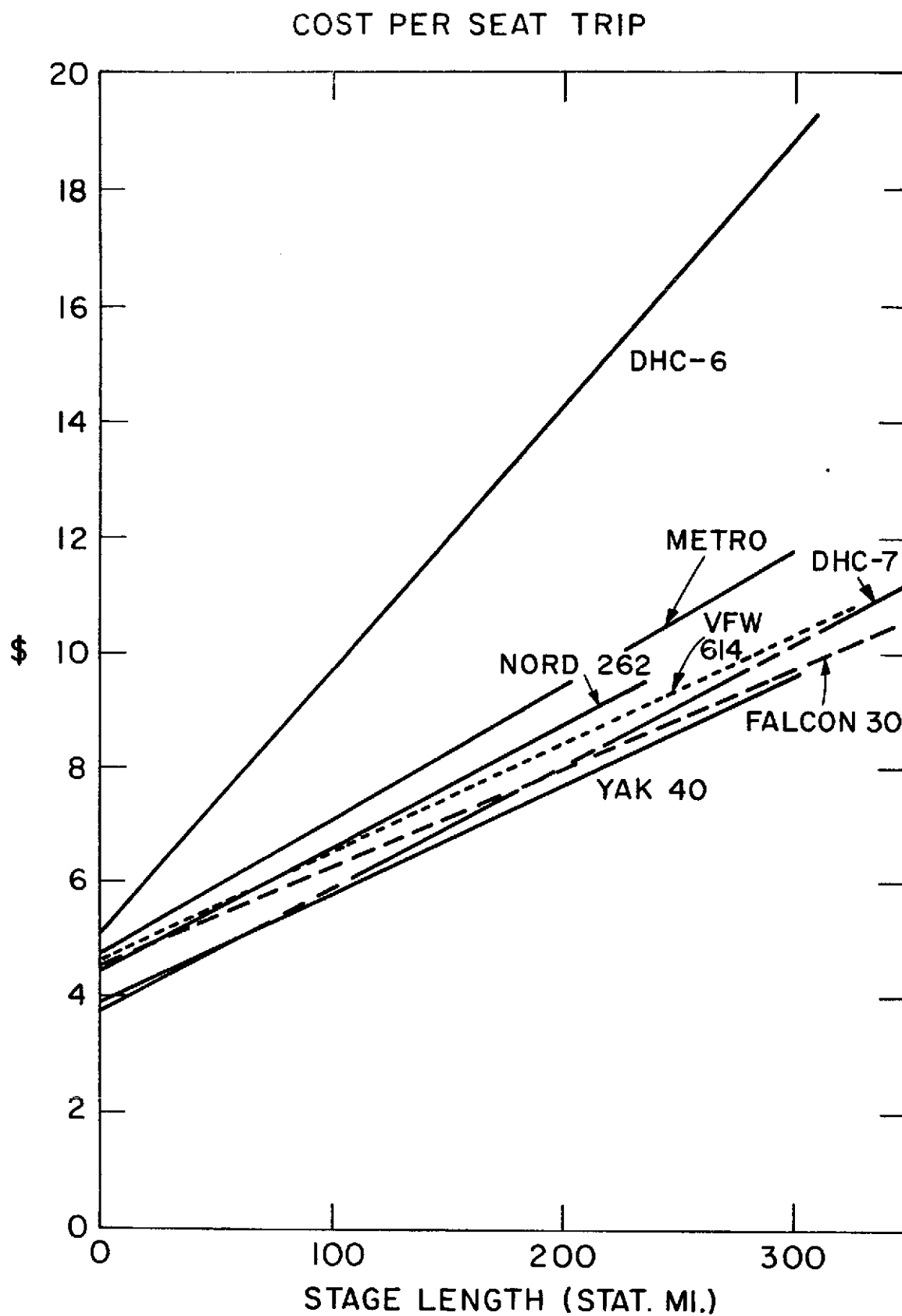


TABLE 3.4
PERFORMANCE COMPARISON

	H.S. 748	F-27-500/ FH-227	F-27	CONVAIR 580	US-40
PASSENGER CAPACITY	40-62	52-56	48	44-56	40
MAXIMUM TAKEOFF WEIGHT (LB)	44,495	45,000	43,500	54,600	43,297
MAXIMUM CRUISE SPEED (MPH)	285	264	265	340	508
TAKEOFF DISTANCE REQUIRED (FT)	4,800	5,450	5,400	4,900	5,700
RANGE WITH MAXIMUM PAYLOAD (MI)	500	650	650	1,000	1,000

FIGURE 3.7

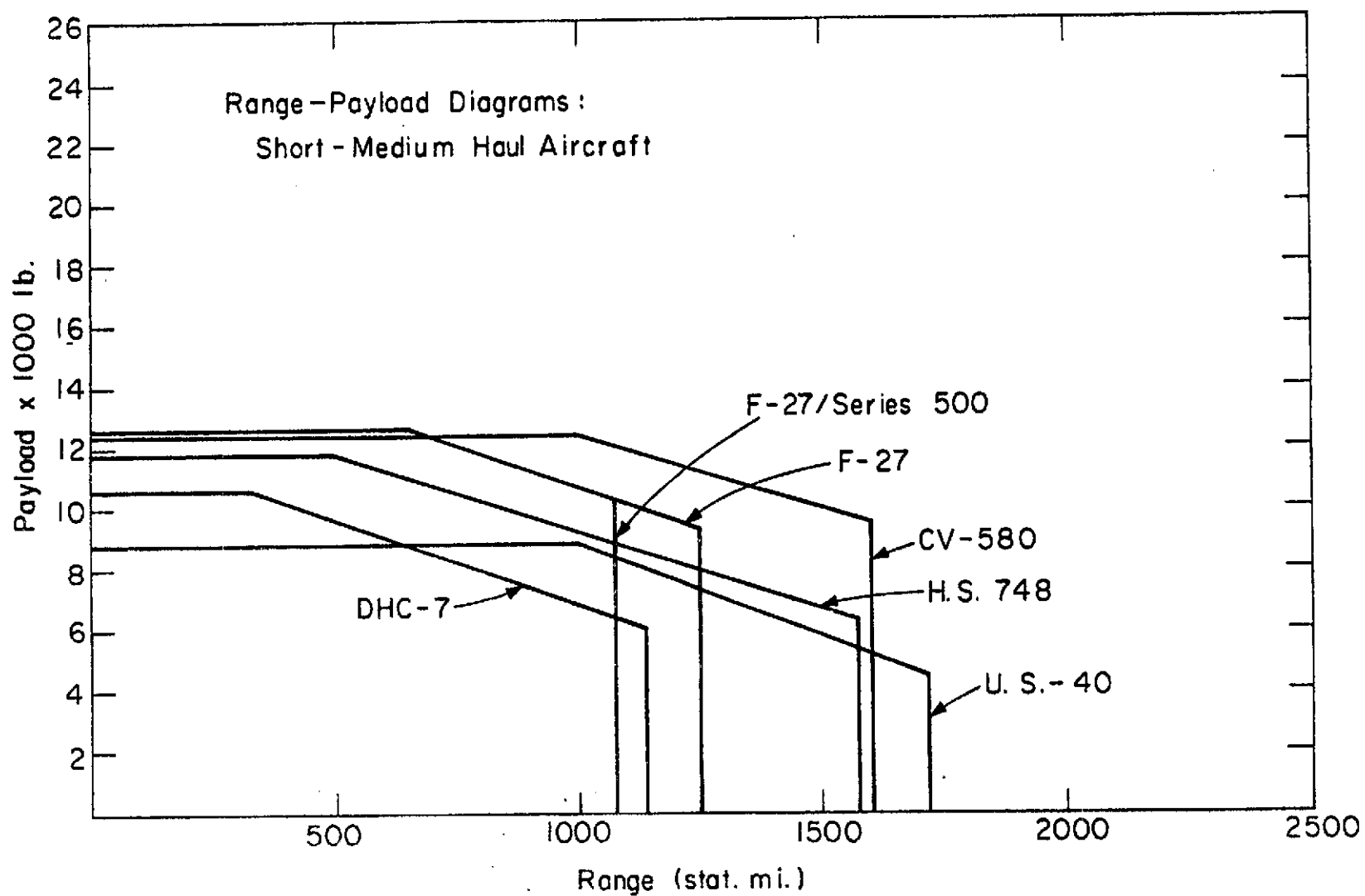


TABLE 3.5
ECONOMIC COMPARISON

	H.S.748	F-27-500/ FH-227	F-27	CONVAIR 580	US-40
\$/BLOCK HR.	246.5	244.8	232.1	194.7	362.0
\$/AVAILABLE SEAT MILE	0.038	0.040	0.044	0.028	0.064
COST PER AIRCRAFT TRIP (\$)	159.19 + 0.74/MI.	146.64 + 0.78 MI.	138.96 + 0.74/MI.	114.98 + 0.44/MI.	194.4 + 0.62/MI.
COST PER SEAT TRIP (\$)	2.57 + .012/MI.	2.62 + .014/MI.	2.89 + .015/MI.	2.05 + .008/MI.	4.86 + .016/MI.

FIGURE 3.8

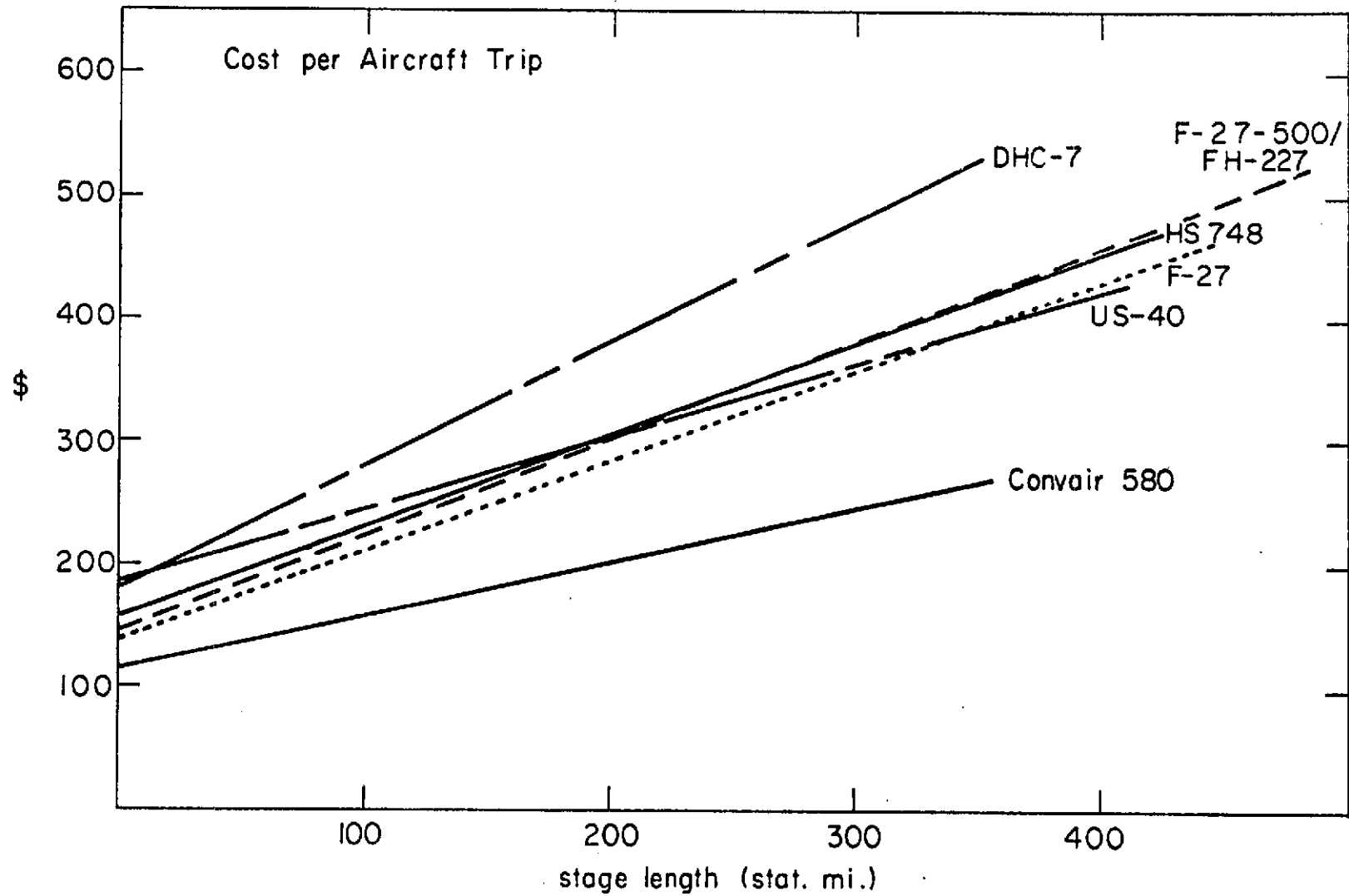
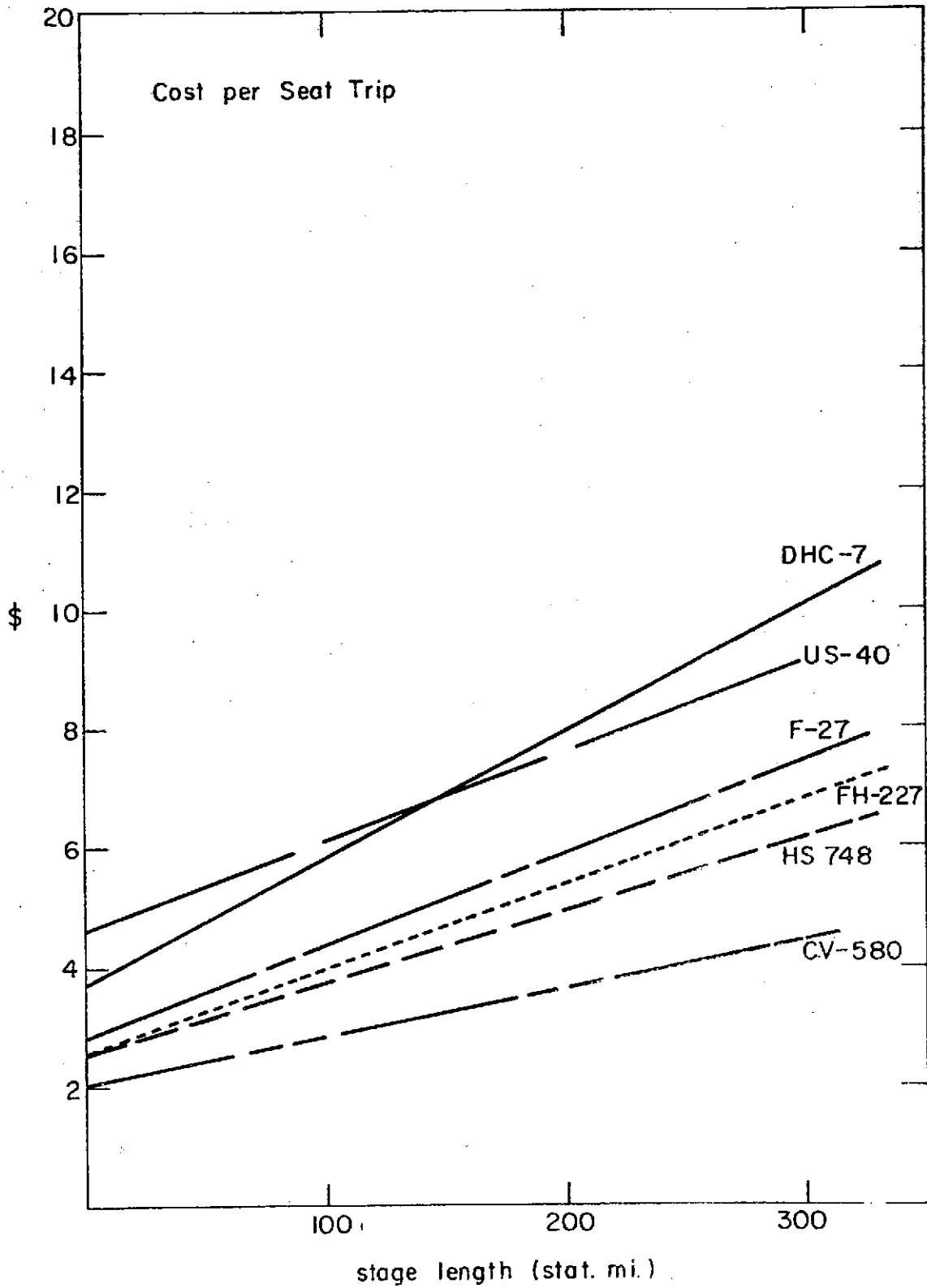


FIGURE 3.9



most attractive on a cost per aircraft trip basis, and because of its higher speed (relative to the DHC - 6) does not fare too badly on a cost per seat trip basis compared to the higher configuration aircraft. Its field length requirements, although not as favorable as the Twin Otter's, are still good (2,800 feet), and in many ways the Metro appears as a reasonable investment for those airlines where a 20 passenger configuration is sufficient and STOL capability (2,000 feet or less) is not required. The Metro, however, has only recently gone into service (Commuter Airlines of Binghamton, New York and Air Wisconsin) and operational experience will show how accurate the manufacturer's estimates are upon which the comparisons were made.

Similar caveats apply to the other non-operational aircraft - the DHC - 7, Falcon 30, VFW 614. It is somewhat surprising to note that the YAK 40, despite its low initial purchase price, does not compare more favorably with the higher priced Falcon 30 and VFW 614. The basic performance drawback of the YAK 40 appears to be its relatively slow cruising speed.

Among the larger aircraft, the old Convair 580 (the Allison turboprop re-engined Convair 340 or 440) appears to be the most attractive aircraft by almost all criteria. On the economic side, the low initial purchase price of the aircraft is partially responsible for the favorable showing. However, even at 3 or 4 times the assumed selling price of \$250,000, the CV-580 is still a substantially superior aircraft on all counts except field length requirements, where the DHC - 7, designed for STOL performance, dominates.

In general, it appears that new jet aircraft do not have any outstanding edge over the turboprops. However, it should be kept in mind that these new aircraft are not designed with low cost being the primary criterion. The US - 40, for example, is designed as essentially a miniature B-747. Cruise speed, take-off and landing performance and passenger comfort standards are equal to those of the latest generation wide-bodied transports. An austere jet transport, more appropriate for low/medium short haul service, would undoubtedly compare more favorably with the turboprops.

3.3 Market Potential

There are two clearly identifiable markets for new aircraft: one is the replacement market, the other is the supplementary market, ie. aircraft needed for expanding traffic patterns. To some degree they overlap, as when airlines decide upon fleet standardization and aircraft are replaced without being obsolete, either in terms of function or market acceptance. However, the division, although artificial, allows a planner to more clearly identify the possible total overall market.

In the low/medium density area, the approximate size of aircraft required is in the 20 -60 passenger range. There is another clear dividing line drawn by the CAB at 30 passengers (at this time), under which commuter air carriers can operate aircraft without full CAB regulation (or certification). They are not exempt from the more stringent safety rules of the FAA (FAR 121) that apply to transport aircraft over 12,500lbs. maximum gross take-off weight.

In the replacement market, it is possible to identify about 2,000 aircraft in scheduled passenger service that are piston or turboprop (Table 3.6). In the United States, the local service airlines have about 200 larger turboprops in service (FH-227, F-27, CV-580, CV-600 and YS-11). Even though these aircraft are still serviceable and quite economical to operate, as noted

ESTIMATED MID - 1972
NUMBER AND TYPE OF AIRCRAFT OF 20-60 PAX CAPACITY
IN SCHEDULED PASSENGER SERVICE IN THE WORLD *

<u>AREA OF WORLD</u>		DHC-6 (TWIN OTTER)	DC-3	DC-4	CV-240 340- 440	CV-580 -600	YS-11	HS748	VISCOUNT (700, 800)	F.27 FH. 227
WESTERN EUROPE	(285)	13	40	16	63	1	8	10	67	67
NORTH AMERICA	(423)	95	50	4	6	133	23	3	20	89
CENTRAL AMERICA	(146) (INC. MEXICO)	44	50	8	19	9	—	14	2	—
SOUTH AMERICA	(280)	17	111	23	28	7	16	40	22	16
AFRICA	(213)	12	92	35	2	4	2	4	15	47
ASIA	(457)	18	141	22	16	3	78	43	33	103
AUSTRALIA + PACIFIC	(172)	22	62	5	—	4	2	6	5	66
TOTALS		221	546	113	134	161	129	120	164	388

* EXCLUDING EASTERN EUROPE AND CHINA

TOTAL = 1976

TABLE 3.6

in the previous section, in due time they will be phased out and replacements needed. A new forty-sixty passenger aircraft would appear to have a ready made market in the United States alone, depending on its economics.

It is probably fair to estimate that at least an equal number of aircraft of the same type are in use by the military or other government agencies. Thus there appears to be a need for 1000 airplanes to (still) replace the DC-3 alone around the world.

Table 3.6 also points out the fact that less than a quarter of the demand for these replacement aircraft is likely to come from North America. This picture is quite different when compared to overall air travel, where about half of the world's total is concentrated in the North American continent. The diverse nature of the demand can be seen by examining Table 3.7, the orders for Fokker F28's, an existing replacement aircraft for the piston and turboprops shown in Table 3.6. It can be seen that not only is demand likely to come from all parts of the world, but that the orders for the aircraft are likely to come in small quantities. This suggests a requirement for world-wide marketing capability. It must also be recognized that orders for a new airplane will not come in a few large lots from a few airlines, but rather in small numbers from a great many sources and likely stretched out over a long period of time.

Table 3.7

F 28 AIRCRAFT ORDERS AS OF FEBRUARY 1, 1973

Air Nauru (Central Pacific Republic of Nauru)	1
Ansett Transport Industries (Australia)	5
Aviacion (Germany)	3
Bonair-Germanair (Germany)	4
Braathens SAFE (Norway)	5
Fairchild Industries (U.S. and Canada)	10
Garuda (Indonesia)	6
Iberia (Spain)	3
Itavia	3
Linjeflyg (Sweden)	3
LTU (German)	4
Martinair (Belgium)	1
Nigeria Airways	2
Government of Nigeria	1
Pelita/Pertamina	1
Government of Argentina	1
Government of Colombia	1
Government of the Netherlands	1
THY (Turkey)	<u>5</u>
	60

The supplementary market is more difficult to determine. Although overall air travel is likely to grow at 7%-12% per annum into the late 1900's, this growth will generate demand for large aircraft (of DC-9 size up) rather than the aircraft useful in the low/medium density area. The growth of commuter air carriers in the United States will likely continue as local service airlines (and trunks) are allowed to abandon marginal points, as well as by traffic increases on already established routes. The structure of commuter operations seems to indicate that their expansionary needs will be met by smaller (less than 30 passengers) turboprops of the Beech 99, Twin Otter, Swearingen Metro, Shorts SD3-30 variety.

New route networks can also be hypothesized for trunks and local service airlines: an increase in the major hub bypass routes; direct service between smaller cities; more hub-and-spoke patterns. Thus a market of supplementing the current fleets with smaller aircraft (40-60 passengers) may also appear in the near future in the United States. However, it is unlikely that this demand will exceed 200 planes.

In summary, the greatest potential market for a low/medium density aircraft will be outside the North American continent, and there will be some 2,000 aircraft of this type that will need replacement in the near future.

4. ECONOMIC ANALYSES

4.1 Basic Issues

4.1.1 Introduction

This section discusses the costs of providing air service to low-density markets, with particular emphasis on the excess of cost over income. The material below is general and illustrative and raises the major economic issues.

4.1.2 Simple Rules for Approximating the Costs of Air Transportation

Air transportation as discussed here is a premium transportation mode. Air travel is faster, safer, and more comfortable than the other existing means of travel. It is, however, more expensive. It is quite possible to construct an air transportation system which has both costs and total time convenience approaching existing bus operations. Such deviations from present conditions are not discussed below. The transportation that is considered is fast, available, and dear. Essentially, it is suited to contributing to the travel and interaction which is part of day-to-day commerce.

As a consequence of this limitation, one unusual, and convenient assumption can be made. That is that load factors cannot rise above 50 %, a maximum average. In short-haul operations most travellers can get a seat if the annual average load factor is 50 percent. Above 60 percent load factor the probability of full flights at peak hours becomes so high that the premium convenience aspect of air transportation no longer applies. Variations within this band can produce as much as a 10 percent change in airline costs, although adjustments to

equipment utilization may compensate somewhat. A 10% variation, is not large with respect to the changes in costs discussed below, so a constant load factor of 50 percent will be assumed throughout.

Thus, the following three statements about airline operating costs can be made:

- i.) The distance dependence of the operating cost of an aircraft can be described in terms of dollars per takeoff plus dollars per cruise mile.
- ii.) The size dependence of the operating cost of an aircraft can be described as dollars per aircraft plus an additional cost for each passenger seat of aircraft design size.
- iii.) Indirect operating costs may be described by five numbers:

IOC per passenger boarding;

IOC per passenger mile;

IOC per aircraft mile;

IOC per aircraft departure;

Overhead as a percent of all other costs;

For the purposes of the discussions to follow, the following numbers will be used to approximate these values:

- i.) Aircraft cost is based on cost per block hour.

Block time = .175 hours + 430 mph. This establishes a linear rise in cost with a distance and a fixed zero distance intercept.

- ii.) Block hour costs (derived from parametric designs done at the FTL) are \$210 per aircraft hour plus \$4.25 per aircraft seat hour. It should not be surprising that aircraft cost should have a part not dependent on the number of seats,

since all aircraft, however small or large, need certain minimums of equipment plus a pilot and copilot.

iii.) IOC's were estimated using a regression analysis of local service carriers reported IOC's* as a general guide. They are:

IOC per passenger boarding = \$5.00;
 IOC per passenger mile = \$0.007;
 IOC per aircraft mile = \$0.10;
 IOC per aircraft departure = \$12.00;
 Overhead = 10 percent.

For a 40-seat aircraft at 50 percent load factor, the linear per-passenger cost-versus-distance relationship depicted in Figure 4.1 results.

A similar plot illustrates the change in per passenger costs with aircraft size and distance. Figure 4.2 is the same relationship as Figure 4.1 but with several aircraft sizes. Figure 4.3 plots the aircraft size dependence for a fixed distance. These figures show clearly the sharp rise in per passenger costs which occurs when traffic densities are low and the aircraft are small.

The most important point to glean from the above discussion is that the cost per seat of an airline service rises as the aircraft size decreases.

4.1.3 Fare Taper and Costs

Figure 4.1 shows the rise of per passenger trip costs

*Simpson and Taneja. A Multi-Regression Analysis of Airline IOC's
 FTL Report 67-2, Dec. 1967.

C-8

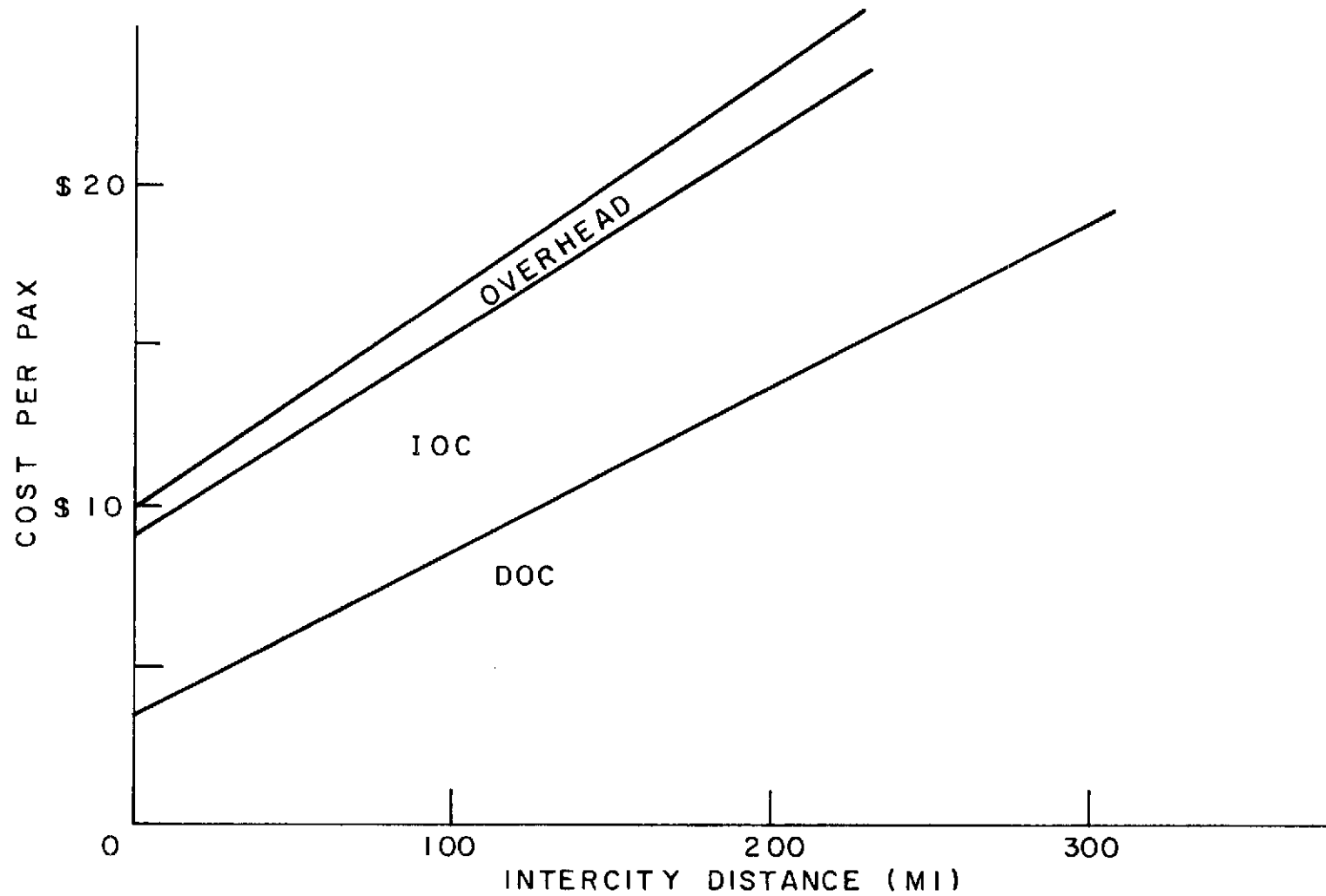


FIGURE 4.1 TOTAL PER PASSENGER OPERATING COSTS VS DISTANCE
40 SEAT AIRCRAFT 50% LOAD FACTOR

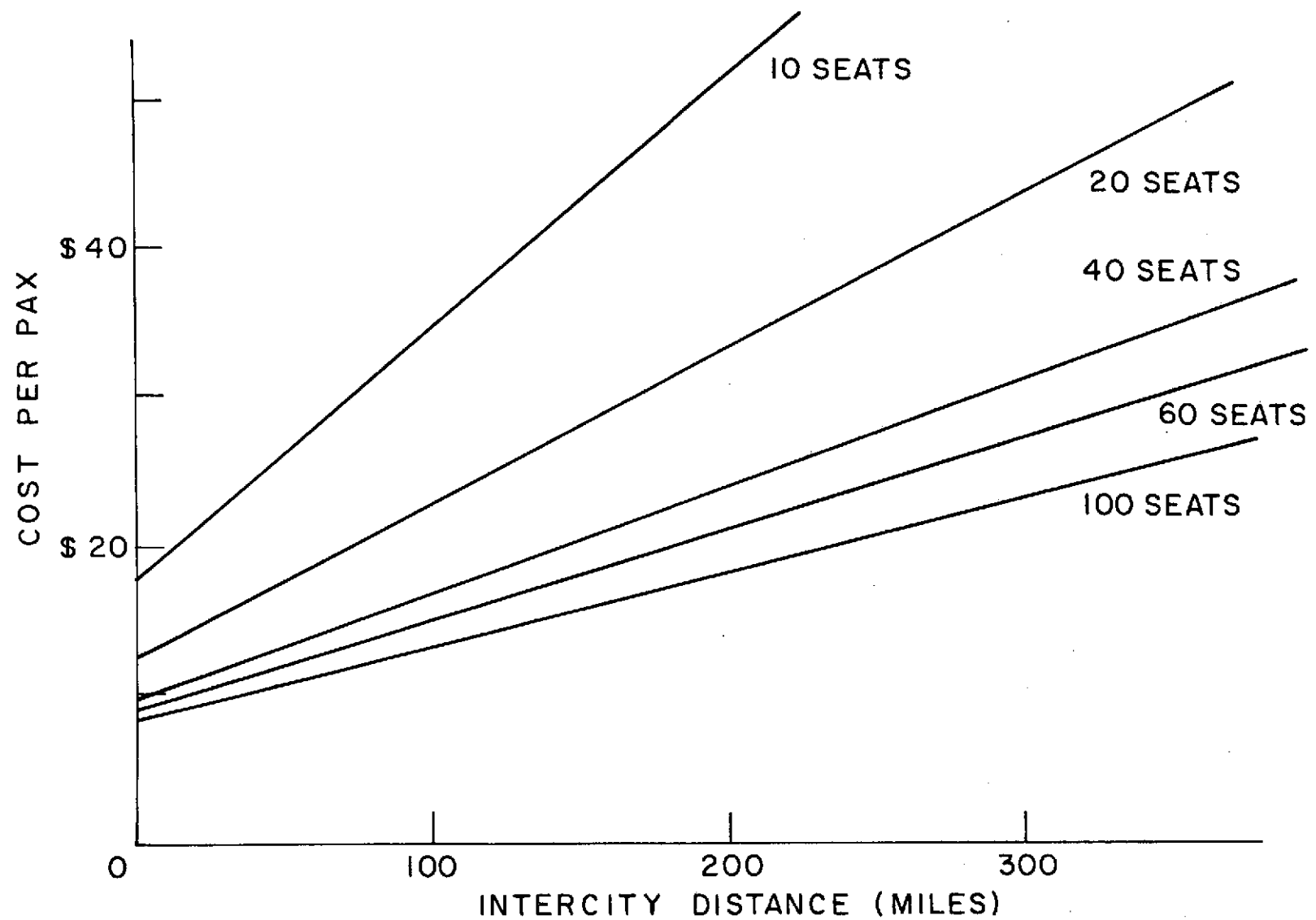


FIGURE 4.2 TOTAL PER PASSENGER OPERATING COSTS VS DISTANCE
SEVERAL AIRCRAFT SIZES 50% LOAD FACTOR

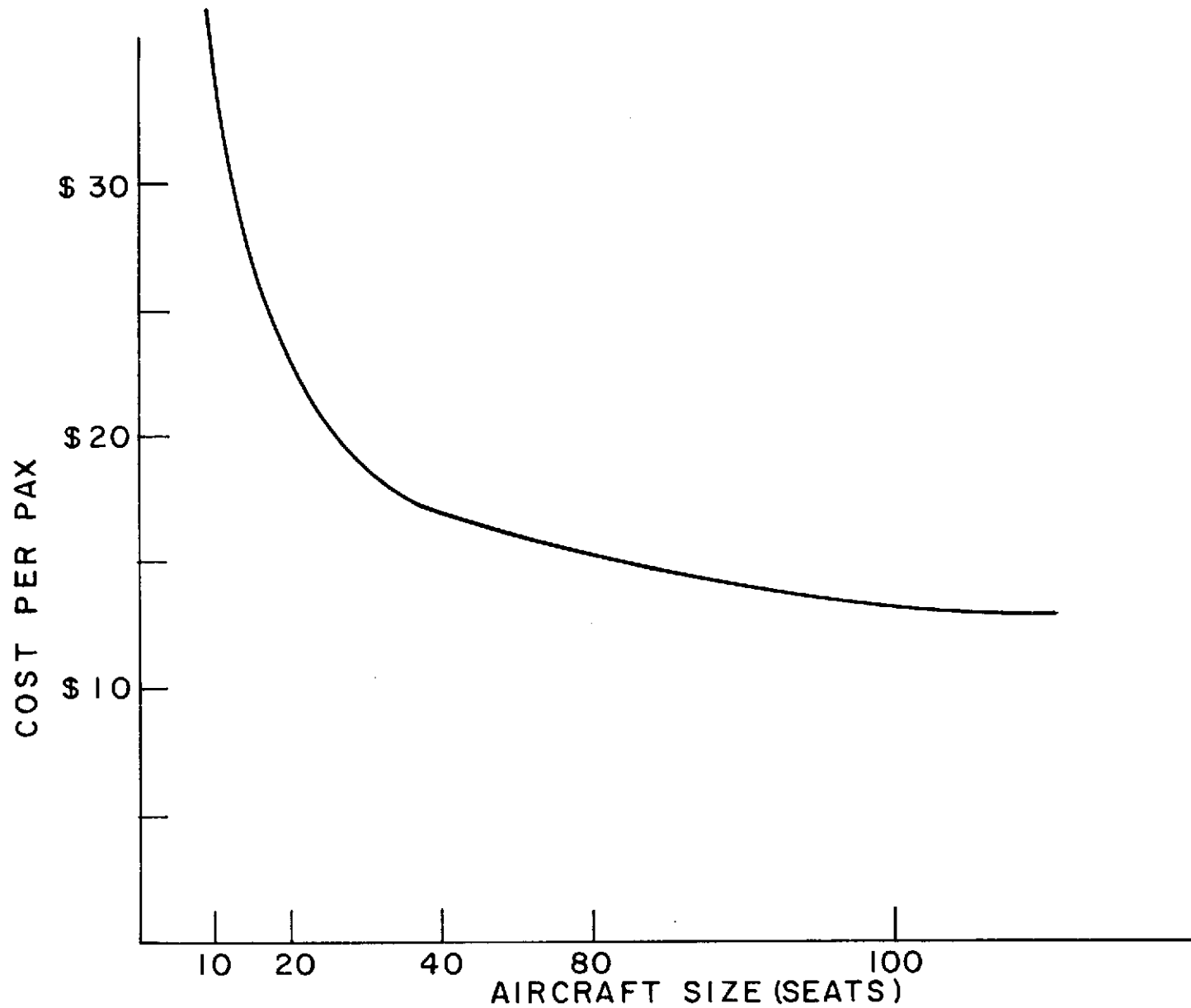


FIGURE 4.3 TOTAL PER PASSENGER COST AS A FUNCTION OF
AIRCRAFT SIZE. 100 MILE TRIP 50% LOAD FACTOR
REGIONAL OPERATING COSTS

with distance for a 40-seat aircraft at 50 percent load factor. Figure 4.4 has the same cost line. In addition, Figure 4.4 has a revenue line representing a typical revenue yield for such distances. The actual fares are diluted to a revenue yield of $\$7. + \0.0735 per mile.* The revenue line is different from the cost line. Thus, trips under 200 miles are bound to lose money at 50% load factor while those over 200 miles can show a profit.

Such a revenue-cost relationship has long existed in short-haul markets, which explains why so few airlines like short haul. However, lately the new fare structures have increased the zero-distance fare necessary to make the revenue line sit above the cost line at very short distances. As this trend continues short haul markets can become profitable.

Fare taper problems occur under similar conditions as aircraft size problems, and tend to exacerbate them. With today's fare structure the aircraft size problem has become the dominant one, and is the only one emphasised in the succeeding sections.

4.1.4 The Revenues: Demand Approximations

It is usually assumed that the demand for transportation can change with changing costs and quality of service. When discussing the air mode, the costs are always above ground modes; but the quality of service is superior. Still, an airline can increase its total traffic by increasing the quality of its service. Common moves are to increase the speed or frequency of a particular service, or to substitute direct routings for connections and multistops.

*The fare level is chosen merely to illustrate the point.

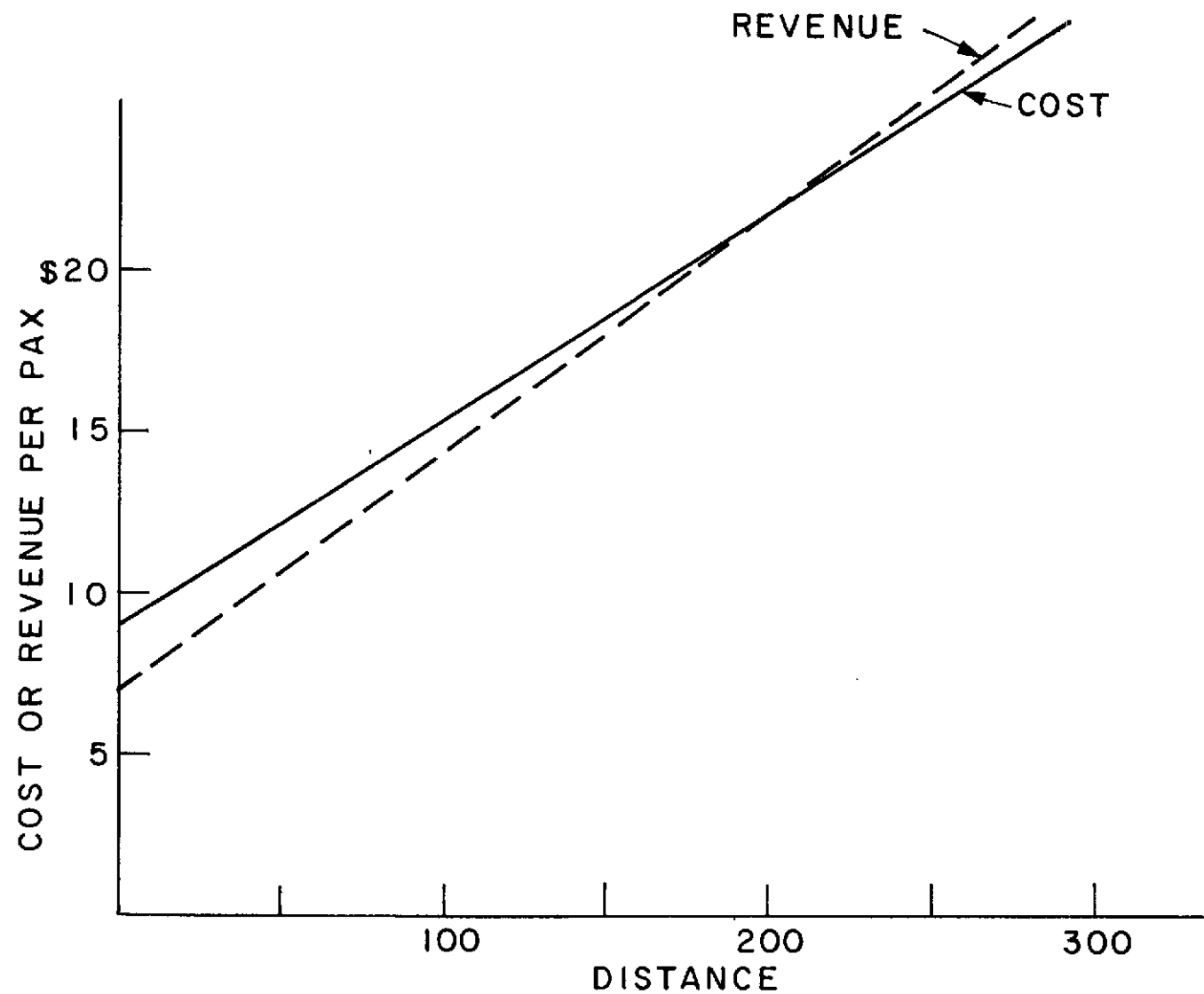


FIGURE 4.4 TOTAL PER PASSENGER COSTS AND REVENUES vs DISTANCE
40 SEAT AIRCRAFT 50% LOAD FACTOR

These moves are a corporate reaction to their perception of demand elasticity with respect to time. The more convenient the service, the more people use it. Mathematically,

$$\text{Demand} = K/T^{\beta}.$$

As the travel time (T) goes up, the traffic goes down (Figure 4.5a). β is the time elasticity, a number typically between 1 and 2*.

The time term (T) in the equation above is usually assumed to be the traveller's total perceived time occupied travelling. This includes driving to the airport, buying a ticket, waiting for the next departure, flying, and getting to his destination. Thus doubling the speed of an aircraft does not, by any means, cut the travel time in half. The other interesting aspect of this total travel time figure is the part called schedule wait. This is the time inconvenience associated with the frequency (or lack of frequency) of service. The schedule wait is usually assumed to be half the average headway. With one or two flights a day, a third flight is a vast improvement; but above 6 or 10 flights, additional service is not important. Mathematically:

$$\text{Demand} = K/(T_0 + W/\text{frequency})^{\beta}$$

Here T_0 is the fixed time (access, egress, and travel), and

*For this discussion a value of 2 will be used, as typical for short haul.

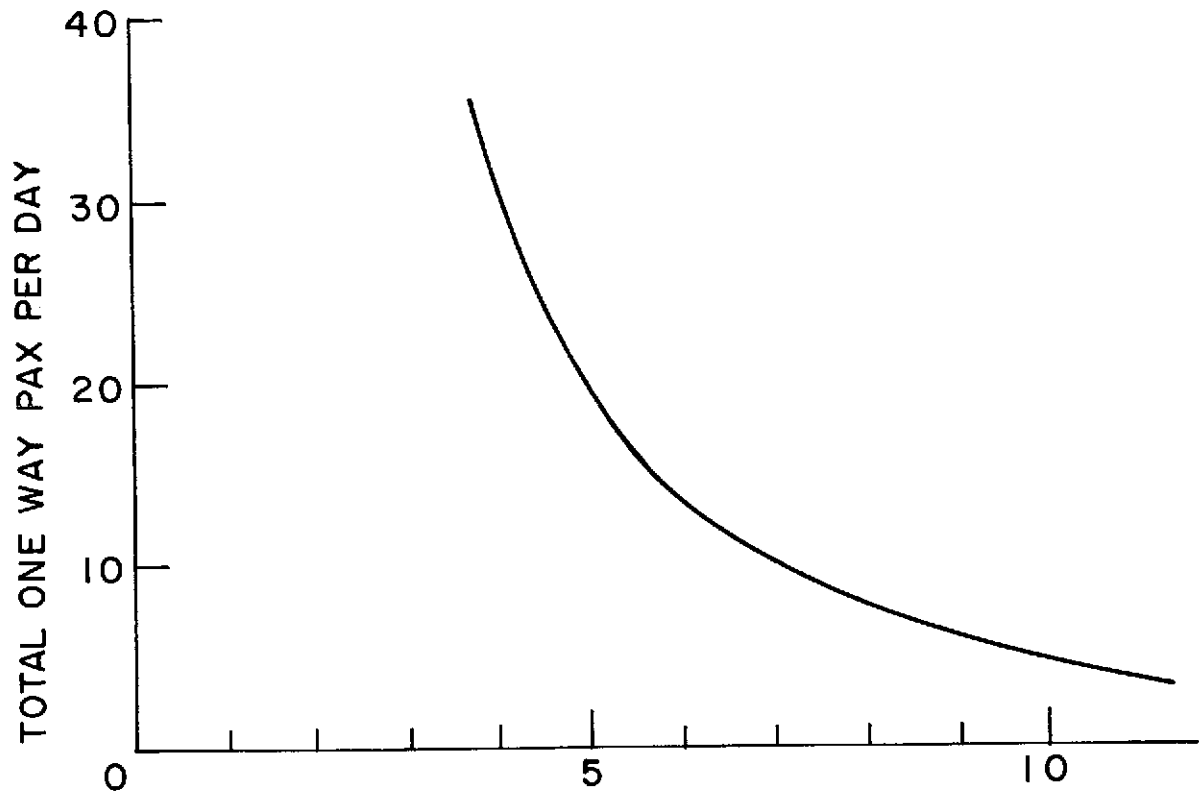


FIGURE 4.5a DEMAND DEPENDENCE ON TOTAL TRIP TIME AT CONSTANT TICKET PRICE 100 MILE TRIP

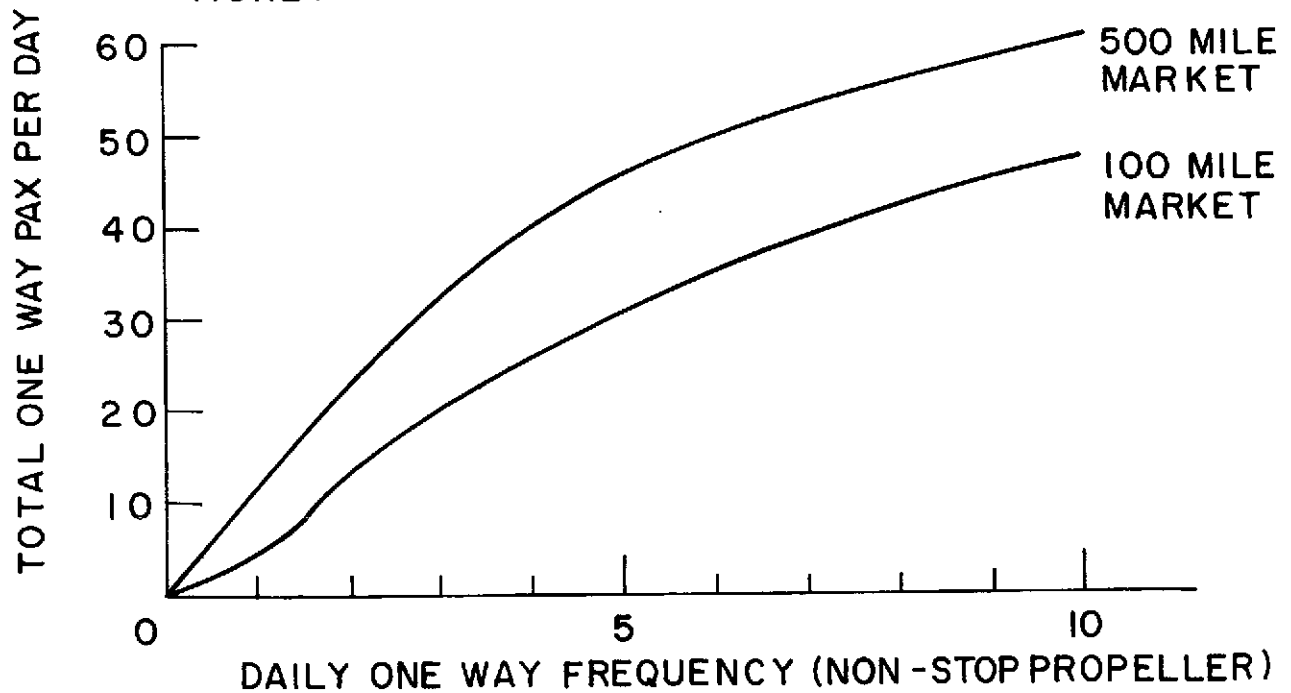


FIGURE 4.5b DEMAND DEPENDENCE ON FREQUENCY (SCHEDULE WAIT) AT CONSTANT TICKET PRICE

W/frequency is the schedule wait. Figure 4.5b illustrates the typical dependence implied by this relationship.

The other, and equally important, way of changing the travel time is to change the T_0 by going to direct routings or faster aircraft. Any reduction in travel time influences the total demand. Figure 4.6a illustrates this variation.

Demand also reacts to the changes in total travel price. A formulation just like the one for time is typical:

$$\text{Demand} = K/P^\alpha$$

Here P is the price of travel and α the price elasticity, which is near 1 or 2. The dependence at $\alpha = 2$, typical of short haul, is illustrated in Figure 4.6b and will be used for the remainder of this discussion.

Both the time and price variation of demand can be expressed simultaneously:

$$\text{Demand} = K/T^\beta P^\alpha$$

The intrinsic market size is specified by K , not by the actual demand under some specific conditions. Passengers attracted depends on service, but the market strength K , does not. K depends on demographic variables such as population, industrial activity, etc. for the city pair market.

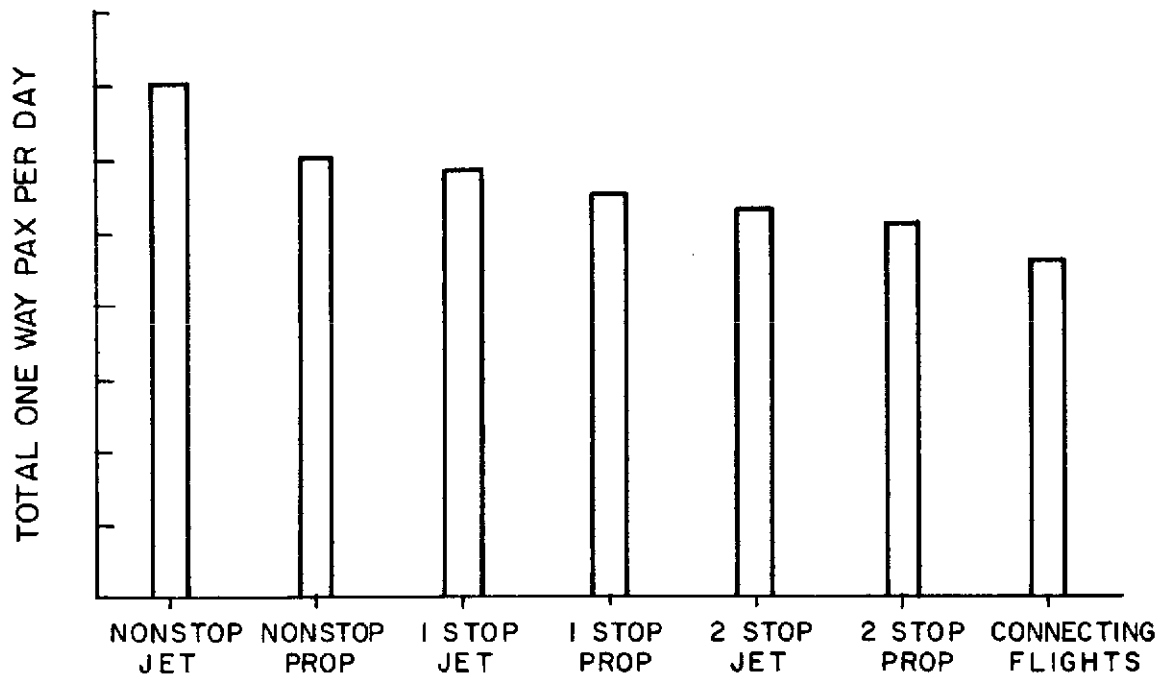


FIGURE 4.6a DEMAND DEPENDENCE ON TYPE OF SERVICE AT CONSTANT TICKET PRICE AT FREQUENCY OF 4 FLIGHTS PER DAY 200 MILE MARKET

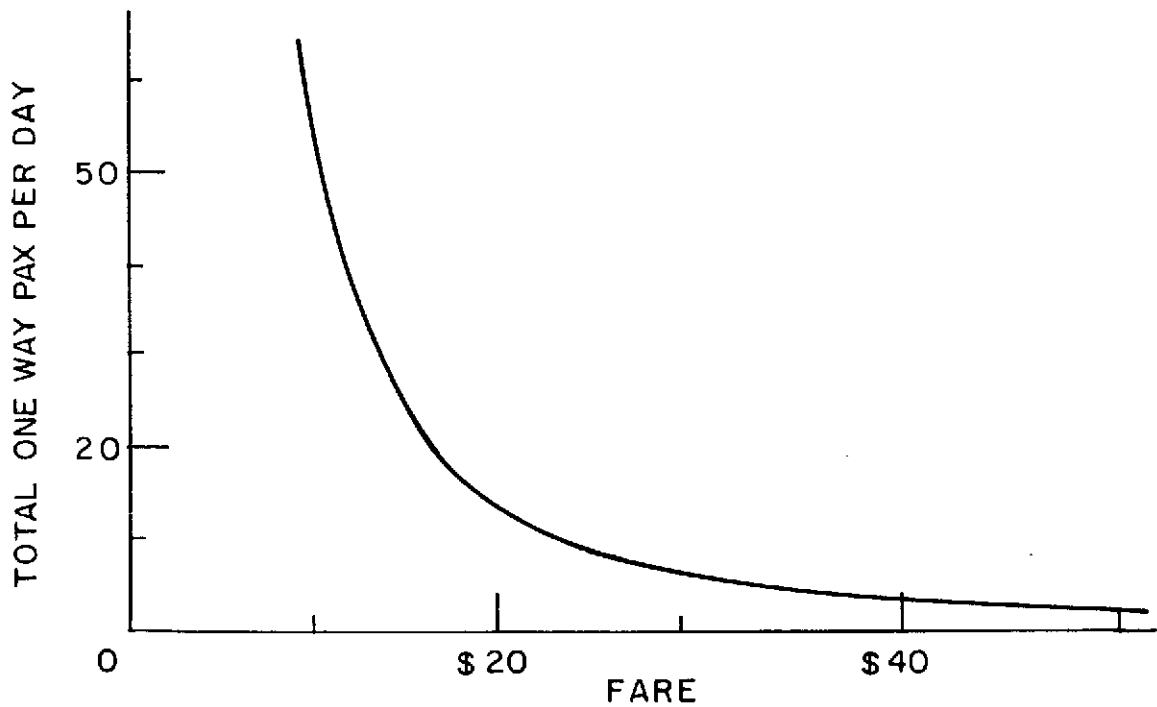


FIGURE 4.6b DEMAND DEPENDENCE ON PRICE AT CONSTANT TOTAL TRAVEL TIME 100 MILE TRIP

K is a small number in low-density markets, reflecting the general lack of interested travellers.

4.1.5 Revenue and Costs: A Free Market Study

To examine the underlying market forces of costs and services it was assumed that an airline has a monopoly and is able to adjust both fares and frequency.

Initially the airline is serving a 100 mile market four times a day with a forty seat aircraft and boarding only 25 passengers a day each way, for an actual load factor of 16%. The net revenue per passenger is \$14.35. The net cost per seat at a "normal" 50% load factor is \$16.87, so even in "normal" conditions the airline would lose \$2.55 per passenger.

Rationally an enterprising airline would use a smaller aircraft. A 12.5 seat aircraft can carry 25 passengers on four flights a day at 50% load factor for a total (one way) cost of \$729. The total cost using a 40 seat aircraft was \$948. In both cases the total revenue is the same: \$359.

Assume the airline attempts to raise prices to cover the new lower costs. The total costs are \$729 under the new scheme, and the total passengers are 25. The breakeven fare at 50% load factor should be \$29.16: this is nearly double the previous fare.

This enormous \$29 fare is the cost of operating the very small 12.5 seat aircraft. Indeed the cost per passenger actually carried on the 40 seat aircraft (which was at 16% load factor) was more, \$37.92 to be exact.

At \$29.16, less passengers show up. The price is too high. According to the demand model only 6 people remain interested in the service.

At this point the airline decides to cut the frequency of service. One flight a day is recommended.

Now the reduction in frequency from 4 to 1 produces an added schedule wait of 6 hours. This increases the total trip time, which discourages traffic. Only 6 passengers a week show up for a once-a-day \$29 trip. The only remaining step seems to be to discontinue service entirely.

The same scenario can be reconsidered with a larger market size. Assume that the starting conditions are fare = \$14.35, and Frequency = 4 flights per day. This time the operator is flying a 60 seat aircraft and carrying 100 originating passengers per day.

At 50% load factor, the cost per passenger is \$12.06, so if the aircraft were fully utilized, a profit would be possible. However, the load factor is only 42%. Revenues are \$1,435 and costs are \$1,551, so a loss is incurred.

The airline attempts to raise the load factor by reducing the frequency of service to 3 flights. The daily traffic drops to 72 passengers due to the decreased convenience of the service. Total income is now \$1,030.00. Expenses are \$1143.00. Load factor is now 40% and the total losses have risen. The reduction in frequency created an even greater reduction in market size through the mechanism of reaction to the level of service.

The management decides to employ a smaller aircraft. A 48 seat vehicle is obtained. The frequency is maintained at 3 flights per day and the fare remains fixed. Because service does not change, revenues do not change (they are \$1030 from 72 passengers). Load factor is 50% Total costs are only \$1026. The airline is finally making a profit.

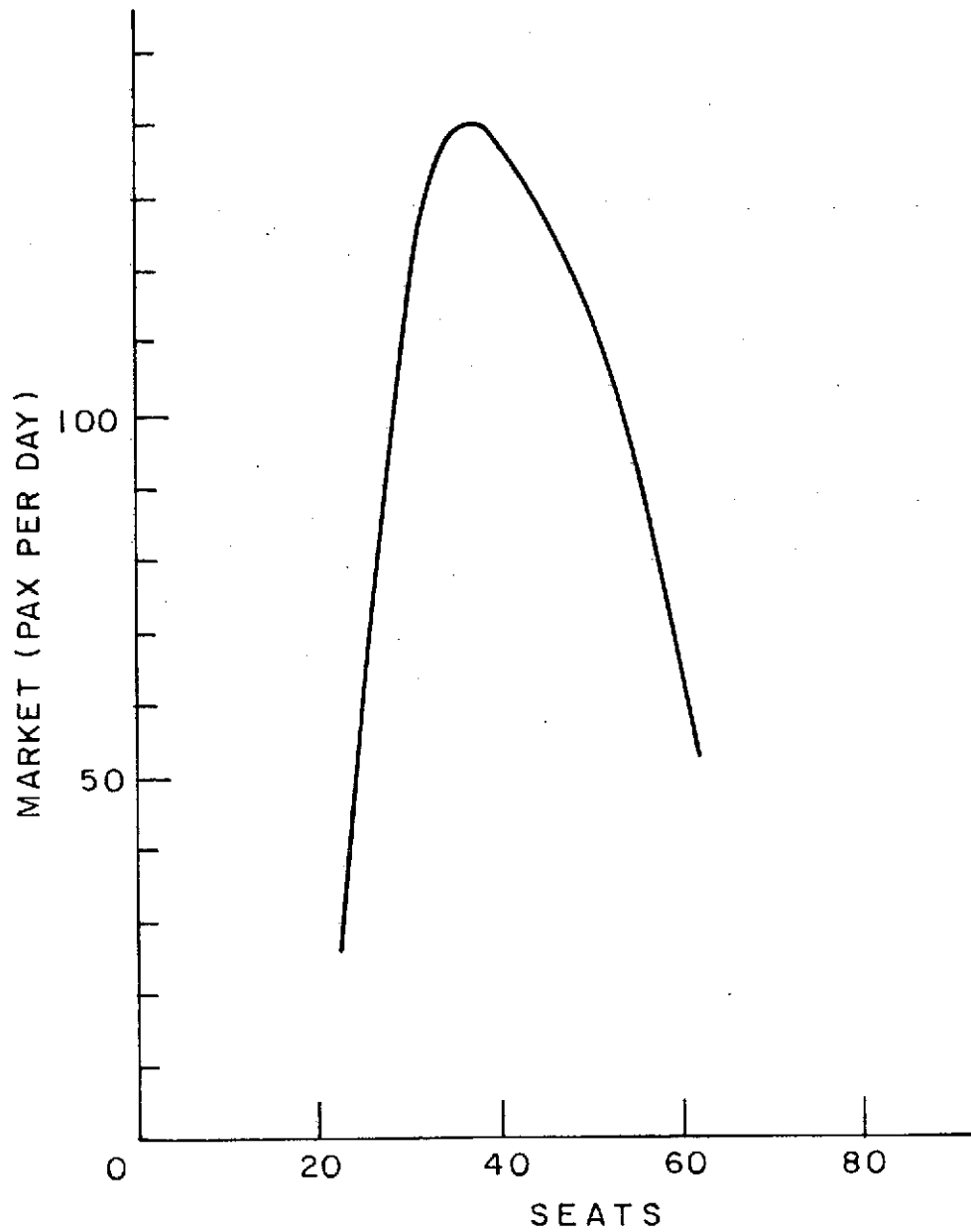
But what if, instead of reducing the vehicle size, they had raised the fare? At 72 passengers the expenses were \$15.90 per passenger. However, at that fare only 63 passengers show up. Rather than raise fares again, the frequency is cut to two flights a day. This reduces the market size to 36. Once again costs outrun revenues. Now a 36 seat aircraft is sought. By now, not even this remedy is sufficient. In fact, at this point only a careful look at the situation will prevent the airline from ceasing to serve what in fact can be a viable market.

Observe that the market started at 100 passengers a day for four flights at \$14.35 a ticket. Since α and β are assumed to be 2, K in the demand function is 288,000. This is the market size or density. If the aircraft size is con-

nuously reduced from some large number, say 100 seats, and at the same time the airline always flies exactly the frequency which generates a 50% load factor, initially the traffic will grow. The small increase in prices (which equals cost in this case) associated with smaller aircraft sizes is compensated for by a sizeable decrease in schedule wait due to the increased frequency. Figure 4.7 illustrates this case. The price rise begins to accelerate as very small aircraft sizes are approached and at the same time additional frequencies above 4 or 5 add little convenience. Eventually the total traffic takes a turn downward.

Thus, for some values of frequency and cost a maximum number of passengers are served. For the 100 passenger market the maximum traffic is 137 passengers. The operating conditions are 7.5 flights per day with a 37 seat aircraft. The fare is \$17.20. Thus with both fare and frequency higher than the starting conditions, more people desire the service. In fact, the demand is twice that achieved in the case above using a larger and cheaper (per seat) aircraft. The larger market is being served in such a way as to please the greatest number of people.

In the study of the 25 passenger market it was seen that some markets can never reach a point where airline revenues equal cost. Between the infeasible and the financially attractive there is a minimum viable market size. This market size can be determined mathematically. In this example it occurs when $K = 256,000$. At 53 origins per day a profit



THE CURVE IS UNUSUALLY STEEP BECAUSE OF THE NEARNESS TO THE MINIMUM INTRINSIC MARKET DENSITY.

FIGURE 4.7 MARKET SIZE AT FIXED LOAD FACTOR FOR
PRICE = COST $K = 288,000$

is shown using a 23 seat aircraft flying $4\frac{1}{2}$ times a day with a fare of \$20.40. If the standard service of 4 flights at \$14.35 were flown it would carry 93 passengers and lose money.

The 25 passenger case had less than one third of the necessary market density. It could not be served at regional airline standards without a loss.

The conclusion of these case studies will come as a surprise to no one. There are some markets too small to be served without subsidy support. The few passengers that are available cannot afford the cost of an aircraft, however small, to provide the service.

4.1.6 The Effects of Regulatory Constraints on the Free Market Solution.

In the real world fare cannot change with costs. Frequency of service in some cases can change. Under these conditions there still exists the tradeoff between operating low frequencies with low incomes and higher frequencies with greater incomes but greater costs. Indeed a point exists where the net profit is at a maximum. For a low density market the optimum is at a minimum loss, which is no service and costs; for higher densities it is at maximum profits. The same basic assumptions apply: various aircraft sizes exist, seat costs increase with decreasing size, and the total passenger traffic responds to frequency of service. With this a relationship for the optimum aircraft size and frequency for various market densities can be developed. Figure 4.8 illustrates this. The horizontal axis is calibrated in terms of passengers

attracted to the basic 4 flights at \$14.35 service pattern.

This corresponds to the market density K. The actual passengers, aircraft size, daily frequency, and daily loss (or gain) are shown for a 100 mile market in Figures 4.8 and 4.9.

The point at which the airline begins to endure a loss occurs at a somewhat higher market density than the free market situation would suggest. The constraint of fixed ticket price prohibits the market forces from seeking the optimal solution.

Below this level, the optimal solution is always no service, because no service generates no losses.

Consider an approximation of the existing regulated conditions in low density markets. In the final and most highly constrained case both fare and frequency are fixed at minimum levels. The fare is \$14.35 for a 100 mile journey, and the frequency of service is four flights per day.

Figure 4.10 illustrates the total costs and total incomes for the situation where the airline always has just the right size aircraft for any market size. Below 110 origins a day, and below a 55 seat aircraft, a loss is incurred on a fully allocated cost basis.

4.1.7 Conclusions of Economic Analysis Without Subsidy

Frequency of service is essential to providing a useful air transportation link. This frequency becomes too expensive to provide for low density markets because of the high costs asso-

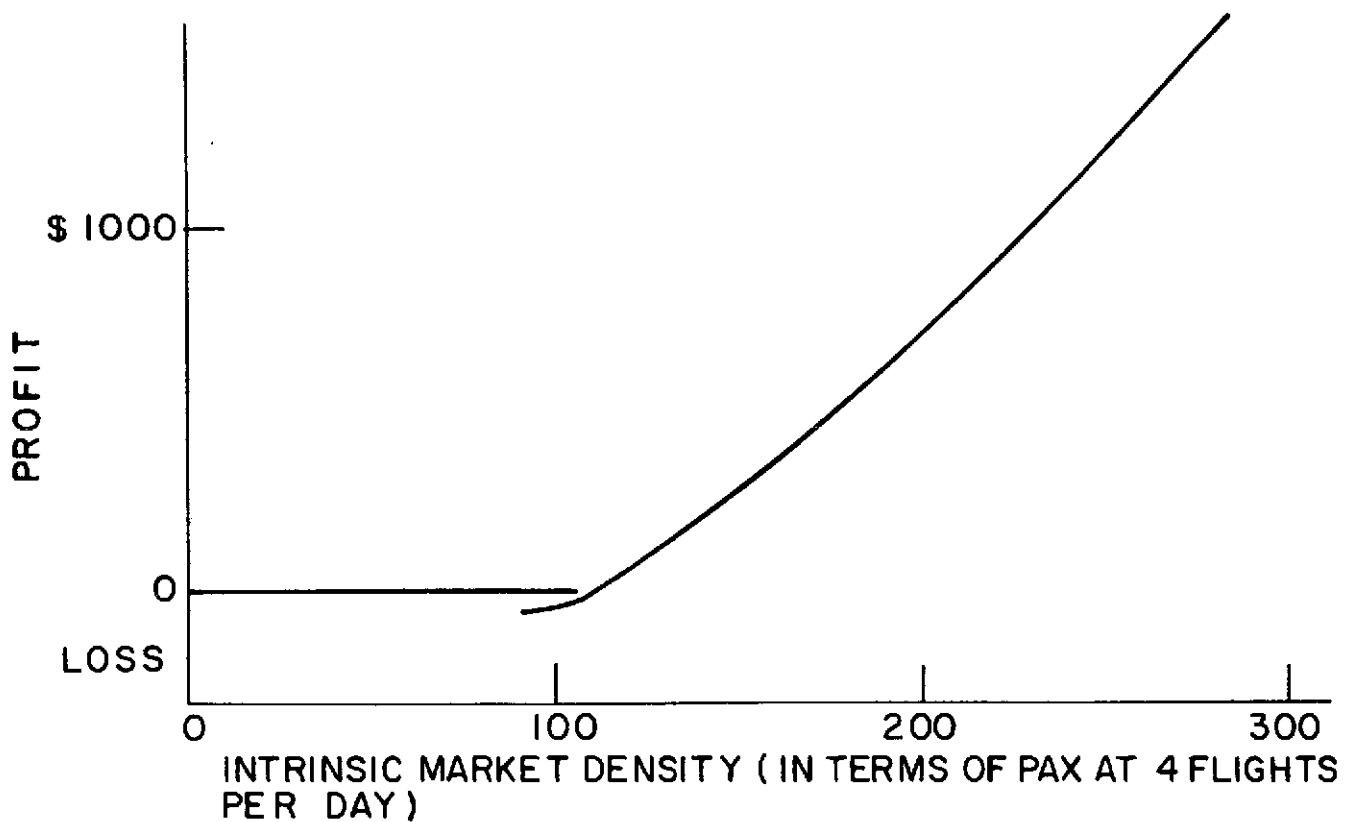
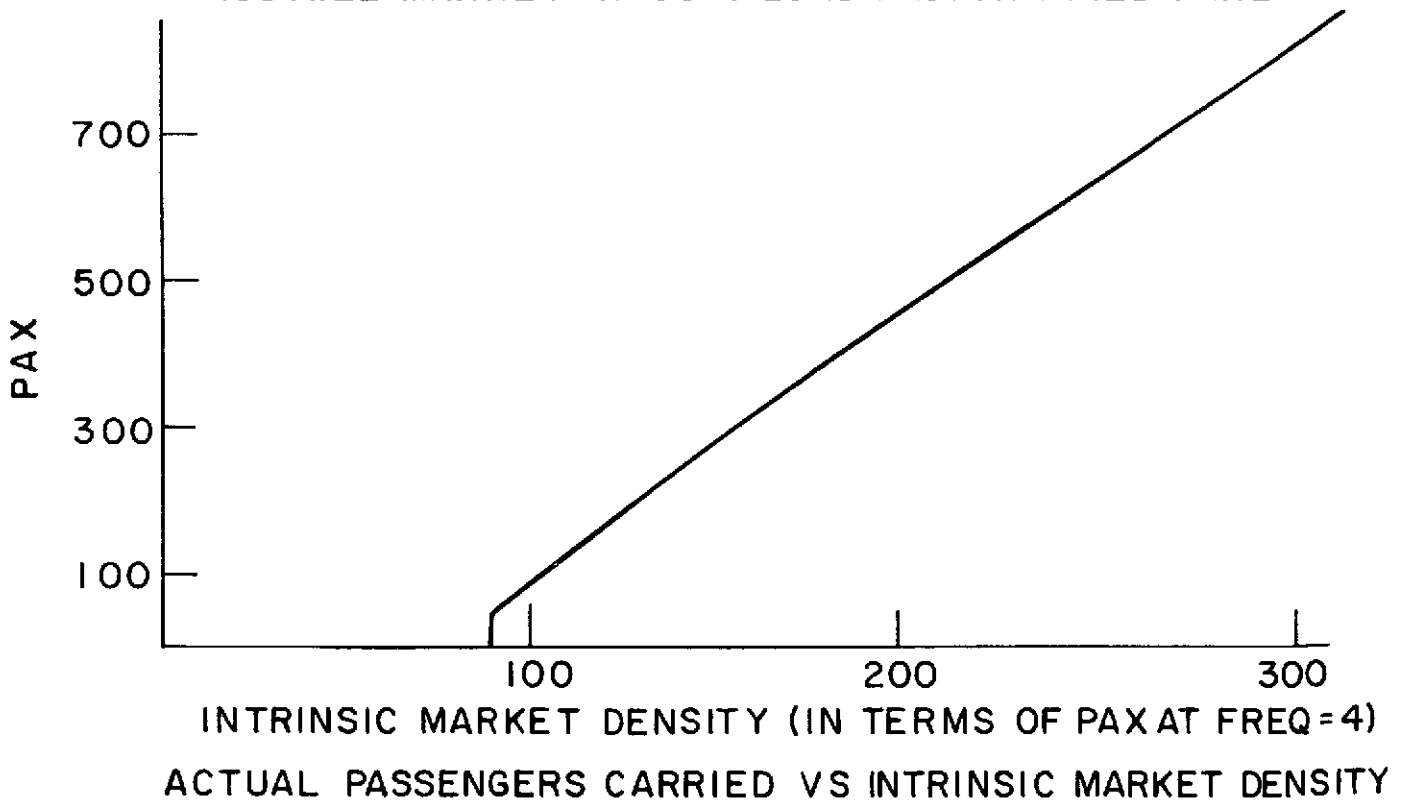


FIGURE 4.8 MAXIMUM PROFITS VS INTRINSIC MARKET DENSITY :
100 MILE MARKET AT 50% LOAD FACTOR FIXED FARE



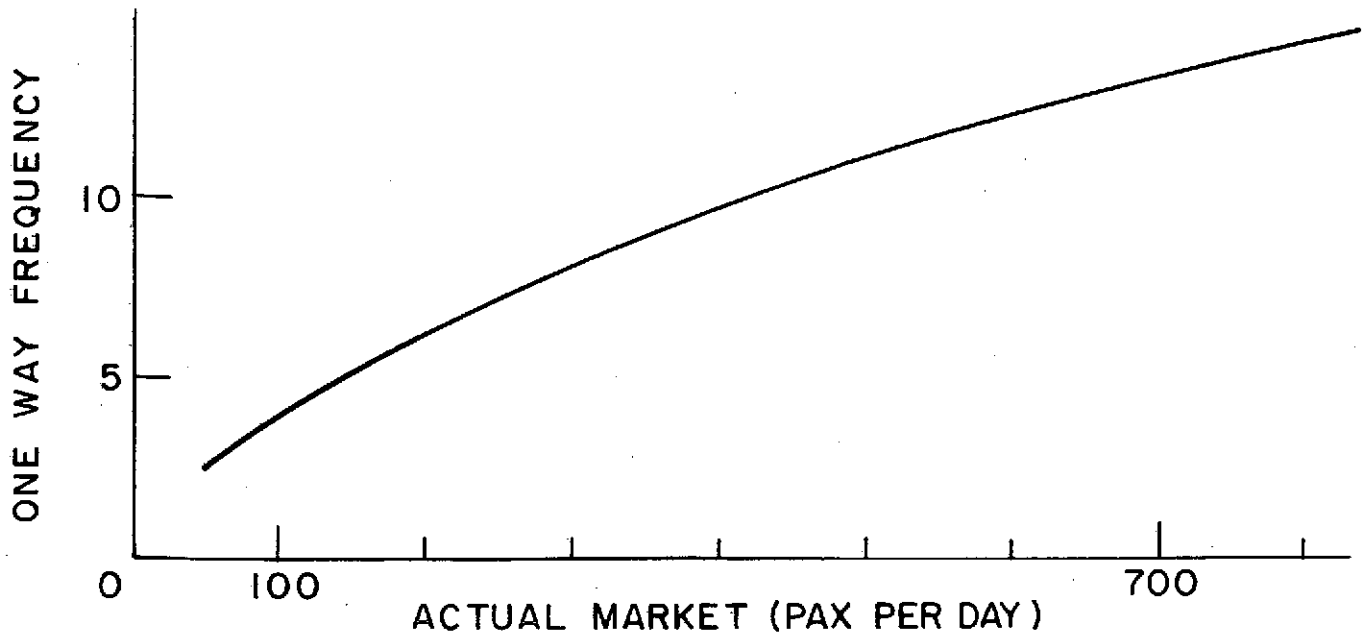
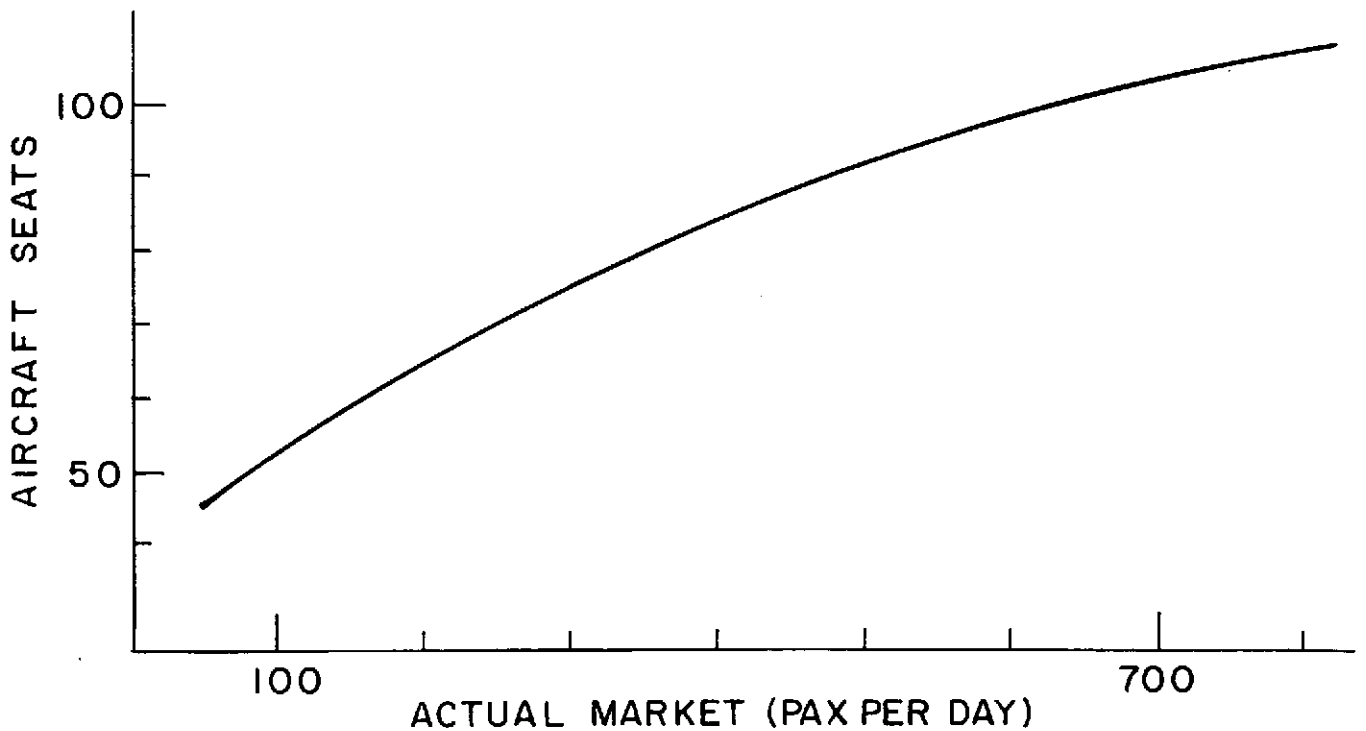


FIGURE 4.9 DAILY FREQUENCY vs ACTUAL MARKET FOR OPTIMUM PROFITS AT FIXED FARE



AIRCRAFT SIZE vs ACTUAL MARKET FOR OPTIMUM PROFITS AT FIXED FARE

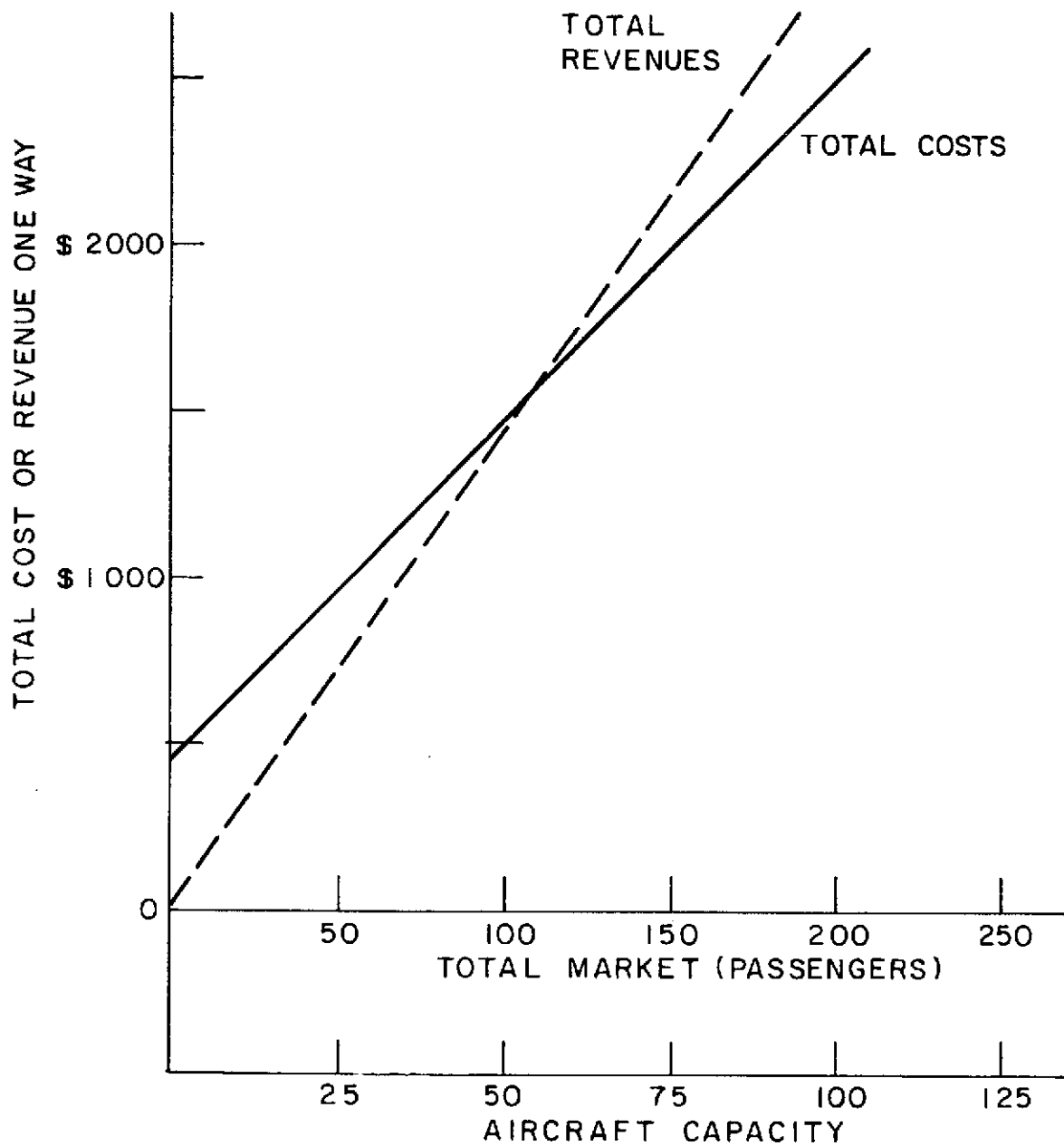


FIGURE 4.10 TOTAL COST AND INCOME VS MARKET SIZE.
 100 MILE FREQUENCY = 4 PRICE = \$14.35
 50% LOAD FACTOR DAILY FIGURES

ciated with the very small aircraft sizes which are appropriate. The use of too large an aircraft quickly becomes too expensive, and can render a marginally viable market impossible to serve without a loss.

It has further been demonstrated that a small increase in the price of a service can sometimes permit a very attractive expansion of that service and a net increase in that passengers carried.

4.2 Subsidy Issues

4.2.1 The Need for Subsidy

Congress has willed that no community of significant size should do without the benefits of public air transportation. This is a matter of public policy, and shall not be discussed below. Wherever the market density is so low that no service can be viable in a free market situation, the government must provide additional payments to the airlines to maintain service. In addition in some cases when the free market would dictate a higher price or the substitution of a commuter carrier, moneys must be made available to compensate for operation at a level of service which is not optimal.

4.4.4 Operators of Subsidized Service

Only two kinds of airlines are willing to provide subsidized air service: the regional carriers and the smaller commuter carriers.

The level of cost and the level of service provided by the regional carriers is close to that which is typical of the biggest and best trunk services in the country. At least

it is possible for a regional air carrier to emulate the highest standards of reliability, safety, and service. It is not at all clear that these carriers always provide the trunkline service standards on routes where passenger revenues do not pay the costs of the service.

Commuter air carriers, however, are viewed as providing less reliable and less safe operations. These two accusations are very likely false in any particular market. The commuters often display greater reliability than the regionals and equal safety standards. Nonetheless the public views commuter service as a reduction from the comfort of service of the regionals.

At low market densities passengers appear willing to sacrifice comfort for convenience. Whenever a commuter successfully replaces a regional carrier, the market responds to a better approximation of its desires. Being caught on the rising part of the cost curve, low density markets relax comfort standards to gain frequency at minimum expense.

Thus, at least today, there are two possible operators of subsidized services - the regionals with higher comfort standards, better image, and higher costs, and the commuters with a greater ability to provide higher frequencies of service.

Historically this has not always been the case. When the regionals were engaged almost exclusively in serving low density markets, they did so with the DC-3, an airplane with which the Beech 99 might be compared today.

However, whoever is chosen to provide subsidized service, it is necessary to choose the most efficient form of the subsidy.

4.2.3 Subsidy on a Standard Cost Basis Adjusted for Income

It is possible to offer to make up the difference between the revenues and the cost of providing some minimum frequency of service by direct subsidy. To do so it is necessary to specify some maximum reasonable costs. The difficulties in this method are two fold:

First the method provides little or no incentive to use the correct size and type of aircraft in providing the service. As long as efficient use is made of the aircraft, and as long as the maximum permissible size is not exceeded, all costs are paid for.

Secondly, there is little or no incentive to provide a quality of service which will actually attract passengers. Indeed if cost savings below the standard costs can be made by a schedule less convenient to the passengers, then the carrier has every incentive to do so because his loss of revenues is covered by the subsidy.

4.2.4 Cross Subsidy

Another method of subsidy to regional airlines is cross subsidy. The airline is given a route which, by its standards, can be served at a cost well below revenues. This excess profit is then permitted to counter-balance losses incurred on low density routes. In effect the monopoly position in the large market is exploited by fixing a higher price* than that which would occur in the economists world of perfect competi-

*The CAB standard fare allows excess profit if market size is large enough, See above.

competition. The resulting uneconomic situation of under-service and over-cost in the dense market is so typical that it is generally accepted without notice. The excess profits are then dedicated to replacing Federal subsidy. Thus, what is called route strengthening by the CAB is a means of levying a tax on a specific set of airline passengers in order to provide a subsidy to a second set of passengers.

In addition this approach leads to the use of two very different aircraft types by the regionals. One aircraft must be small enough to provide subsidized service where the per trip costs must be minimized at the expense of seat costs. The other must be large enough to have per seat costs below the fixed fare levels in the higher density routes. It is interesting to note, too, that the large routes are usually much longer hauls than the smaller aircraft can even serve.

4.2.5 Subsidy on a Bid System

The bid system of subsidy is an economist's dream. A perfect utilization of resources is guaranteed. No over payments or disincentives to economy exist. In addition, there is at least some incentive to increase passenger traffic through high levels of service.

Under the bid system, a small community will be connected to the nearest hub by at least four flights a day. The fare must not exceed \$20 a trip, and the aircraft used must fly under Part 121 regulations for the next 3 years.

If there is a sizeable market and if the stop fits nicely

into the existing route networks, perhaps a regional carrier would put in the lowest bid. If not a commuter carrier, one with a small aircraft such as a Cessna 402, would win the contract. The commuter might fly 6 times a day at \$18 to maximize his profits.

The bid system seems to solve all the financial problems with elegant simplicity. However, there are some objections:

1) Safety of service may slip if the operation loses money. There is a suspicion that FAA is unable to prevent a carrier whose total operations are losing money from cutting corners on maintenance and operations.

2) Service may be terminated by bankruptcy. This seems preventable or remediable by any number of simple rules. The posting of a performance bond seems most promising.

3) Service may be provided at a token level merely to "buy in" to the market. In general, the carrier who first and continuously serves a market would have high expectation of receiving the CAB franchise (route award) for a semi-permanent monopoly in the market. In this case some markets might be auctioned off at a "negative" subsidy.

4) There is still no incentive to maximize service in order to maximize passenger revenues in cases where the number of passengers is extremely small. Here even the marginal cost of service exceeds the marginal revenue.

5) The dramatic change in subsidy policy may render the existing fleet of 40 to 60 seat aircraft owned by the regionals less valuable. This effect is discussed in Chapter 6.

4.2.6 Subsidy by Aircraft Lease

Many markets which cannot be economically served or which cannot be economically served at existing fare levels can be rendered attractive if the operating costs of the airlines are cut. One way to reduce the operating costs is to reduce aircraft DOC by leasing aircraft from the government for \$1.00 a year. It has been said that no airline buys an aircraft to minimize losses. Thus by "forcing" a small aircraft on the regionals in place of subsidy it is possible to override the equipment decisions of the management and favor economic services to small communities. Unfortunately this move has other consequences:

- 1) The presence of an artificially cheap aircraft would make it in the regional airlines interest not only to serve markets presently in need of subsidy but to increase service to many other markets beyond the point that supply and demand had previously indicated was best. Thus the regionals would use two or three "free" aircraft for every one it would use if it had to pay the full costs. The government underwriting of the costs would double or triple.

- 2) The presence of an artificially cheap aircraft immediately depreciates the value of all aircraft of similar size on the market. The government is presumably liable for this loss both from present owners of such craft and from manufacturers whose future markets have been eliminated.

- 3) The perfect size aircraft for subsidized markets is far from constant. In places where density is extremely low and no other markets of similar size are nearby, even a five seat aircraft may be too large. In cases where two or three

remote towns can be served on the same route, a 60 seat aircraft may be just right. The optimum aircraft size depends on both airline network and market density effects.

4) The provision of a "free" aircraft does not reduce costs sufficiently to guarantee service to most of the low density points currently subsidized.

4.2.7 Defining Level of Service

The above discussions of subsidy method should indicate that one of the arts of managing subsidized service lies in stating what service is desired. The normal market forces do not encourage the airline to best serve the existing passenger traffic. In fact in any market which is not of itself viable, the airline is naturally advised to minimize costs without attention to loss of revenues. Therefore, minimum levels of service must be specified.

Any degree of freedom left to the operator will be exploited. This is the opposite of the case in viable markets. In medium and high density markets, the fare is fixed and all other aspects of service are left to the operators discretion. Thus by varying frequency and comfort, the operator can come close to achieving the overall service package which the free market forces might suggest was optimal. For subsidized service, everything must be fixed:

- fares
- frequency of service
- scheduling of departures
- routings - nonstop or multistop
- aircraft comfort
- aircraft safety

There is some difficulty in matching these requirements to the needs of the several types of subsidized markets. Service to remote communities requires timing with respect to connecting flights. Service in low density non-isolated markets requires high frequencies to compete successfully with ground transportation. Service to communities whose claim is based on historical or political grounds requires, perhaps, merely the dignity of service rather than its convenience. In any case the level of service in any individual case is a nice balance between local needs and national expense.

4.2.8 Alternatives to Subsidy

The need or desire for subsidized air service in low density markets may be reduced in the future. The first method of reducing subsidy can be a reduction in cost with a minimum loss of convenience. This could be done by a number of means:

- 1) A reduction in aircraft size. The use of light planes to offer service in small markets can provide a service schedule at reduced costs by reducing the number of empty seats flown, with very little loss of convenience.

- 2) A reallocation of services from two flights a day in two directions to four flights a day to the nearest hub. A single higher frequency service can increase the perceived mobility of people in both isolated or non-isolated communities and cause noticable traffic growth.

- 3) The use of high frequency service on alternate days. It may well be possible to provide a useful schedule of departures to a community on an every other day basis at much reduced cost. A periodic schedule of services permitting

round trip journeys to be completed in one day may be an improvement over one which forces all trips to be overnights.

4) Call stop routings may permit services to be offered to some small points only at hours when passengers actually exist. Thus points would be bypassed unless passengers actually existed on the specific day. This is really only a small saving in cost and perhaps less effective than subsidized air taxi services.

5) The last and most talked about means of reducing subsidy is the use of commuter airline service standards in place of existing higher cost regional carriers. Although costs may be immediately cut in half, and service improve, the regulatory system has not in the past been able to prevent growth into a cost structure not so well designed for low density service.

The second method of reducing the subsidy bill is to reduce the number of points where service is deemed a need. This can be done by imposing various limits or encouraging other means of providing the service:

1) In non-isolated subsidized markets service can be dropped entirely.

2) In isolated subsidized markets the local community can be urged to provide some of the subsidy for what is, in fact, a local benefit. Pueblo, Colo. has persuaded Frontier to provide service up to local standards in this manner. Other communities offer implicit subsidies to commuters and regionals. In some cases ticket sales have been locally guaranteed.

3) In some locations subsidized bus service might provide a suitable alternative to air. This is particularly true in short range operations, where the overall speed advantage may lie with the bus.

4) Subsidized services could have a maximum per passenger subsidy limit of \$10 or \$20.

5) Subsidized operations could be subject to an active "use it or lose it" limit of 20 boardings a day.

4.2.9 Summary of Subsidy Issues

The prime difficulties in managing subsidized services lie in knowing how to devise the regulations to achieve the desired ends with a minimum of cost. The operator has every natural incentive not to provide service since costs exceed revenue. Thus the desired service must be clearly specified, and the means of subsidy designed to reward the operator for achieving those ends with a minimum of cost. The service as perceived by the passenger should be specifically controlled, while the means of achieving that effect left to the managerial abilities of the airlines.

There appear to be ways for encouraging more economic performance of existing benefits and for discriminating among markets where benefits are few and costs are high and those where a little subsidy creates a lot of service.

4.3 Freight Potential

4.3.1 Local Service¹

The freight ton-miles for the local service industry grew from about 7 million in 1962 to over 65 million in 1972 - an average annual growth of almost 25 percent. In contrast the trunk lines expanded from about 475 million tons to over 2 billion tons during the same time period, but at an average annual growth of only 16 percent. Freight revenues represent about 4% of the locals total revenues (60% of the public service revenues) as compared with 6% for the trunks.

The local service carriers view freight as a by-product service as the trunks have for years. It is, however, an important service to many of the small communities they serve. This creates a problem when a local carrier either deletes a point, or is replaced by a commuter operating small aircraft without the freight capacity. Often business in the town suffers.

If new aircraft are to be designed for the local service industry, the need for freight capacity must be kept in mind. It offers the potential of offsetting passenger losses in many lower density markets if the capacity exists and is properly marketed.

4.3.2 Commuters

Although the volume of freight handled by the commuter carriers is relatively small compared to the local and trunk carriers, there is tremendous potential for growth in this area. In 1971, the 123 commuter carriers listed with the Civil Aeronautics Board carried

¹ Data derived from Air Transport Facts and Figures. Air Transportation Association of America (1973)

almost 30,000 tons of cargo², a 28 percent growth over the previous year. If mail is included, they carry about a fourth of the total cargo volume handled by the local service carriers.

One of the major problems facing the commuters is the imbalance between in-bound and out-bound freight. Since these carriers are known locally, they generate out-bound freight. In-bound freight, however, has generally been transferred from the certificated air carriers to motor carriers and not to the commuters. Shippers also use the motor carriers since the commuter carriers were not listed in either the Air Freight Directory published by Air Cargo Inc. or the Air Cargo Guide.

To alleviate this situation about forty commuter carriers and air taxi operators have signed an agreement with Emery Air Freight Corporation to carry Emery Air Freight shipments on a priority basis, using Emery airbills and the Emery computer system for tracing, rating, routing, and billing of traffic. This agreement should balance the in-bound and out-bound traffic flows. Also, the commuter carriers are now listed in the Air Cargo Guide under Commuter Airlines Air Freight Directory. This will provide a significant exposure to the shippers and consignees, especially those desiring service to and from the off-line communities.

The Emery agreement should give the commuters access to freight which is currently transported by surfact carriers to and from off-line communities and "hub" cities for transportation by air. The Cargo and Mail Conference of NATC reports that

"under this agreement, the carriers would bring freight to and from some 303 smaller cities and jet hub centers where major Emery installations are in operation. Of

²In addition these carriers transported 50,000 tons of mail--a growth of 38 percent over the previous year.

these 303 communities, 202 are unserved by any form of regional or trunk airline service."³

This change will improve the financial conditions of the commuter carriers and at the same time provide local industries with improved channels of distribution, saving a full day in transit time.

Another area of significant growth in commuter freight traffic is the carriage of small package shipments. This is an unprofitable area for the large certificated carrier because of high ground handling costs. The certificated carrier is therefore interested in handling only large shipments.

The commuter carrier, on the other hand, with low overhead costs and aircraft of smaller capacity, can offer service to the shipper of small packages. An example is Federal Express, a truly small package airline. The carrier's jet equipment and routes are designed to transport small packages overnight, with door-to-door delivery using a fleet of company-owned courier cars. In addition, the company owns and operates a million dollar sorting facility which can handle ten thousand packages every hour.

The commuter carriers can also achieve economies through consolidation. Emery, for example, consolidates shipments of normal cargo traffic aboard the smaller commuter aircraft using Quarter-D containers. Four of these containers fill the standard D container used on the DC-9 and other aircraft. The Quarter-D container allows the commuters to achieve the economies of containerization and more effectively penetrate the local markets they serve.

³Air Cargo & Mail News, November 17, 1972. Published by Cargo and Mail Conference, division of National Air Transportation Conference.

Present commuter aircraft offer little cargo capacity when fully loaded with passengers and baggage. The next generation of commuter aircraft must provide a significant improvement in this area in light of the rapid cargo growth. The new Metro offers a moveable bulkhead that allows partial conversion to cargo on lightly travelled flights. Quick change capability is also essential so aircraft can be converted to cargo use during off hours and rapidly be reconverted to meet peak passenger demand. This is a valuable way of using excess mid-day capacity, particularly for the carrier whose trade is largely a morning in, evening back, origin-destination traveller.

5. SURVEY RESULTS

To evaluate markets for a 19 to 60 passenger aircraft, all continental local service airlines and representative commuter and other carriers were visited. In addition, several manufacturers were interviewed to discover what their market surveys of these markets indicated. Finally, interested government and trade associations were contacted. Normally the interview took place with vice-president of planning or his senior staff.

Table 5.1 lists the parties visited.

TABLE 5.1

Carriers, Manufacturers, Government
and Associations Contacted

Local Service Carriers

Allegheny
Frontier
Hughes Airwest
North Central
Ozark
Piedmont
Southern
Texas International

Commuter Carriers

Air New England
Air Wisconsin
Altair
Command
Executive
Golden West
Metroflight
Pilgrim
Ransome

Other Carriers

Aspen
Wright

Intrastate Carrier

Southwest

Manufacturers

Beech
Boeing
Cessna
Fairchild
Grumman
Lockheed-California
Lockheed-Georgia
McDonnell-Douglas

Government

Civil Aeronautics Board
Bureau of Operating Rights
Dept. of Transportation
Policy and International
Affairs
Advanced Systems Development
and Technology
Transportation Systems Center

Trade Associations

Associations of Local Transport Airlines (ALTA)
National Air Transportation Conferences (NATC)

Rather than using questions and answers a general discussion of the topic area was encouraged. After explaining what the project was about and the purpose of the visit, the person being interviewed at a carrier was asked a rather broad question such as "What are your future growth plans and what type of aircraft is needed?" Similar questions were used at the manufacturers and other groups contacted.

This approach was very effective in drawing out candid opinions and exposing secondary issues that might not otherwise have been discussed. However, it does make it difficult to report the results without adding subjective interpretation. Likewise, it is difficult to group answers to see if patterns emerge. A survey that asks "Do you want a 50 passenger plane? Yes or No? Why or Why not?" lends itself to statistical evaluation much more readily than the discussion approach. With these difficulties in mind, the results have been tabulated according to rough categories to present the data more meaningfully. Although judgement was used in grouping the answers, the following tables are presented as objectively as possible to accurately reflect the carriers views. However, there may be some minor inconsistencies from one set of tables to the next due to the grouping process. The text following each table is admittedly a subjective interpretation of those views.

5.1 Carrier Survey

The general topics discussed were:

- .Future growth plans
- .Aircraft requirements
 - Size
 - Jet vs. Prop

- STOL or VTOL
- Other Characteristics
- .Cost trade-offs between purchase price and operating costs
- .Effects of unionization on these issues
- .Potential impact of the Part 298 change allowing commuters to use 30 passenger aircraft
- .Views on present subsidy system
- .Views on proposed bid system

TABLE 5.2Growth Plans - Local Service Carriers

All	Seek more long haul routes
1	Seeks trunk status within the next few years
2	Seek expansion of long haul service by developing more regional bypass routes
5	See a moderate expansion of the basic service area

5.1.1 Discussion of Table 5.2

Long haul routes are the major source of profit for airlines under the present fare structure. As the local service carriers acquire more jet aircraft capable of performing long haul segments and learn to integrate them with their systems, they see their profit potential increasing enormously. Since resources are not unlimited, it is in the carriers best interest to invest in these higher profit routes and equipment.

The extent of expansion into long haul routes is determined by each carrier's financial condition, route and market structure. While only one carrier has the proper mix of those elements to eliminate its subsidy-eligible routes in the near future, several would like to do the same. About half, however,

felt they would and should not abandon service to the subsidized points they were created to serve as long as there was enough subsidy to cover losses. This latter group plans to concentrate on gaining long haul routes that integrate points on their systems, particularly those acquired during the route strengthening program of the 1960's.

TABLE 5.3

Growth Plans - Commuter and Other Carriers

- | | |
|---|---|
| 1 | Plans to expand its role as a high density, hub-and-spoke feeder. |
| 1 | Plans to primarily expand its role as a high density, hub-and-spoke feeder, but is looking for longer haul markets suited to high density STOL operations. |
| 4 | Plan to expand service in high density areas, not as hub-and-spoke feeders, but by providing origin-destination service between larger hubs and smaller communities in the megalopolis corridors. |
| 6 | Plan to expand service in regional feeder markets, particularly where service is abandoned by local service carriers. |

5.1.2 Discussion of Table 5.3

Half the carriers in this sample serve high density markets and half provide service from low and medium density points into hubs, clearly indicating the two distinct roles of the commuter airline. Since all the carriers interviewed have been in existence for some time, they know how to compete in the type of market they serve. Therefore, it is quite reasonable that their expansion plans are based on the type of service they already know and provide.

TABLE 5.4Local Service Aircraft Requirements

- | | |
|---|---|
| 4 | Plan to upgrade to an all-jet fleet composed of presently available aircraft of the DC 9, BAC 111, and 737 class. |
| 3 | Would like a jet replacement for present turboprops. |
| 1 | Would like an all jet fleet, but would be interested in a new under 70 passenger turbo-prop if required to continue service to subsidized points. |

5.1.3 Discussion of Table 5.4

The carriers planning all present-day jet fleets are generally those planning the largest expansion, either to trunk status or through the development of regional by-pass routings. However, many of their present markets cannot support the smallest of these aircraft. As a result, these points will be deleted from the system whenever possible. These carriers are pragmatic. Rather than wait for an aircraft that would be appropriate for their route structure, they will modify their network to use the existing aircraft.

The remaining local service carriers have taken the opposite approach. For one reason or another they do not feel they can abandon all the points in their systems that will not support a current-generation jet. Consequently, they seek a new aircraft to replace their aging propeller aircraft to serve these lower density points. Three of these carriers felt the aircraft had to be a jet. The fourth, however, would be interested in a modern turboprop because of its potentially lower operating cost on short haul, low altitude segments.

TABLE 5.5Commuter Aircraft Requirements

(also includes inputs from locals with small aircraft experience)

- 4 Would like to upgrade their fleets
 to 40-50 passenger aircraft in the
 next 3 to 5 years.
- 3 Would like to eventually operate both
 40-50 and under 20 passenger aircraft
 at the same time.
- 2 Felt that an under 20 seat aircraft will
 be satisfactory into the foreseeable
 future and that there is no need for
 anything larger.
- 3 Would like to have a 30 passenger air-
 craft.
- 4 Felt that a 30 passenger aircraft has
 little potential because of FAA regu-
 latory constraints.

5.1.4 Discussion of Table 5.5

The variety of opinions concerning aircraft reflects the diversity in the commuter industry itself. Carriers seeking 40 to 50 passenger aircraft are those operating in fairly dense markets. Often their routes are long haul, with a higher percentage of origin-destination traffic than the high density, hub-and-spoke operator.

This latter carrier is the type that would like to have both large and small aircraft. Since the key to a successful hub-and-spoke-feeder operation is frequency, they cannot use all large aircraft that could not be flown as often economically. Smaller planes are needed for frequency. But a few large aircraft could be used in peak markets which already have enough frequency. In areas where airport operations are limited, the carrier must use larger aircraft to provide peak capacity rather

than add extra sections.

Those who felt that an under 20 seat aircraft would meet foreseeable needs have not yet saturated their markets with frequency. Their growth is still based on providing more flights, and the under 20 seat aircraft is cheaper to operate on a per-flight basis.

Carriers desiring a 30 passenger aircraft felt it was the best compromise between per seat cost and per trip cost. Although a 40 passenger aircraft would have lower costs per seat, the cost of the total trip would be higher. If the extra 10 seats are empty, the 40 passenger plane would not be as productive as the 30. On the other hand, once an aircraft has more than 19 seats, the FAA requires a stewardess. Since aircraft of this size also exceed 12,500 pounds gross weight, additional FAA certification and maintenance costs must be met. These additional costs must be spread over 25-26 seats to reduce the per seat cost below that of a 19 passenger aircraft. Finally, under the CAB's Part 298, as modified in 1972, a commuter can operate a 30 passenger aircraft without economic regulation by the Board. This also encourages the commuter to use a 30 seat plane.

A second group of carriers felt the 30 passenger aircraft was useless for almost the same reasons. They did not think that 30 passengers were enough to offset the regulatory cost of exceeding 19 passengers and 12,500 pounds. This would require at least 40 seats. Those who thought they could use 40 seats much preferred it to a 30 seat version. Those who could not use 40 seats said they would prefer to stay at 19 or below. The decision for 20, 30, or 40 always depended on the specific carrier's cost and route structure.

After the formal survey, informal discussions were held with some of the smaller commuters serving thin markets. They need a better aircraft in the 10 seat range - again a function of their specific cost and route structure.

5.1.5 Interest in STOL or VTOL

None of the local service carriers had any interest in STOL or VTOL. They did not see any requirement for these types of aircraft in the markets they serve now or might serve in the future.

Some commuters, however, had a different response. Although STOL capabilities were not important to operators in low density areas, there was a great deal of interest among the high density feeder carriers. STOL capability is absolutely essential to at least one operator, since one of the major points he serves only has a very short STOL runway. Two operators found it economically essential to have STOL aircraft. These operators both fly into Kennedy using its short runway. They have developed procedures with the air traffic controllers permitting them to operate on a non-interference basis with the regular traffic pattern. They do not get into the duty runway queue, thus avoiding both traffic delays and higher landing fees. The savings made possible by STOL are the difference between their financial success and failure. Several other operators felt that STOL was not essential but operationally convenient for many of the same reasons.

Three carriers expressed an interest in VTOL aircraft. Two, as high density feeders, saw VTOL as a way of serving downtown areas, particularly to the outlying airport. The other carrier operated into areas where the terrain was mountainous and would find VTOL capability a great asset.

5.1.6 Power Plant Requirements

Almost all carriers thought two engines were preferable to four. Although four provide better engine-out performance, this was outweighed by maintenance considerations.

The commuter carriers had little preference as to the type of power plant. Prop, propjet, propfan or pure jet were all acceptable. The choice was based not on which one had more appeal but which one had the lowest operating cost, including depreciation on investment. Since cost is the criteria, the turboprop is the best engine for commuter aircraft both in terms of initial cost and low altitude, shorthaul operating costs. A high bypass variable pitch fan might satisfy their needs in the more distant future.

The dominant interest in cost was tempered somewhat by environmental considerations. Noise and chemical pollution are not issues for the commuters at most points they serve. There are isolated problem areas, however, and the operators see the potential problems that might arise in the future. The turboprop was therefore more acceptable for environmental reasons also.

In contrast, 7 out of 8 local carriers thought any new aircraft had to be jet powered.

5.1.7 Jet Appeal

When questioned in depth on why local carriers felt a new aircraft had to be jet, they tended to rely on "motherhood" statements like "The passenger expects jet comfort, and trunk-type service", or "People won't fly props anymore". These statements are in direct conflict with the commuters' experience that reli-

ability and frequency were more important than equipment type. Yet every carrier had an example, usually on his own airline, where the introduction of jet service increased traffic.

Several of these examples were pursued in detail and in every case there were a number of other factors surrounding the introduction of the jet that could have produced the same result. For example, the new jet service was always accompanied by an advertising and promotional campaign. No one knew of a similar attempt to advertise the preexisting prop service. In another case, the jet was used to provide one stop service in place of a five stop turboprop flight. In another, the introduction of the jet was accompanied by new through and joint fare agreements that essentially let the passenger fly for free. (It should be noted that these fare agreements had been rejected by the connecting carriers on the basis of disparate service before the jet was introduced.) Finally, one community used the introduction of a jet as a tool for changing people's attitudes about flying from the local airport instead of driving to an alternate facility. (See 5.2)

The only clear connection between jet service and traffic generation was traced to travel agents. Jet service gives the agent an additional selling point when arranging for travel from a small city. At least one agent did not feel people would respond to pressure to ride existing turboprops, but he could talk them into trying the jet instead of driving. Whether or not his feelings were correct, he actively sold jet

service. If other travel agents feel the same, the carrier would definitely see an increase in traffic when the jet is introduced but because of additional selling by the travel agents, not merely because a jet aircraft is being used.

5.1.8 Other Aircraft Characteristics

All agree that any new aircraft should be pressurized and air conditioned. The local service carriers take this for granted since most of their aircraft have had these features for several years. Since few commuter aircraft have pressurization or air conditioning, it is more important to these carriers. There were many stories of passenger discomfort on bumpy low altitude flights, particularly on hot days, and very high altitude flights under any conditions.

Because of the short haul nature of both the local service and commuter industries, all carriers were concerned about hydraulic systems and lower maintenance breaks and flaps. One local service carrier estimated the break and flap maintenance on the F 27 at \$3 to \$4 per operation.

5.1.9 Cost Trade-Offs

In general, commuter carriers are initial cost conscious because of limited capital resources and limited, high cost credit. These factors are more important than aircraft performance or efficiency, although the latter two are not ignored. Most felt an aircraft priced at \$750,000 was pushing their resources, and anything over \$1 million was prohibitive.

In contrast, the local service carriers are more concerned about operating costs than purchase price, although some admitted

they would have difficulty financing a major re-equipment program at this time. Most felt that 2.5 million would be about right for a 50-60 passenger aircraft.

In actuality, the important factor is not how much the aircraft cost or what it costs to operate, but whether its productivity will offset those costs. The commuters and locals both intuitively solve this question, evaluate their cash flow problems and integrate the results to decide how much they will pay for an aircraft.

5.1.10 Unionization

This is not a major issue for local service carriers since they have been unionized for some time, Table 5.6 lists their union affiliations. Most commuters, however, are afraid of unionization. They see the rates and rules of the local service industry and realize they could not survive under such a cost structure. Those who have been unionized, however, have discovered that many of their fears are unfounded. The unions have realized the tenuous financial positions of many commuters and their demands have been within that framework.

TABLE 5.6

Local Service Union Affiliations*

<u>Airline</u>	<u>Pilots</u>	<u>Flight Attendants</u>	<u>Flight Dispatchers</u>	<u>Mechanics</u>
Allegheny	ALPA	ALPA	NONE	IAM
Frontier	ALPA	ALPA	TWU	IAM
Hughes Airwest	ALPA	ALPA	TWU	AMFA
North Central	ALPA	ALPA	TWU	IAM
Ozark	ALPA	ALPA	ALDA	AMFA
Piedmont	ALPA	ALPA	TWU	IAM
Southern	ALPA	ALSSA	NONE	NONE
Texas International	ALPA	ALPA	TWU	IAM

ALPA - Air Line Pilots Assn.
 ALDA - Air Line Dispatchers Assn.
 ALSSA - Air Line Stewards &
 Stewardesses Assn.

AMFA - Aircraft Mechanics Fraternal Ass
 IAM - International Assn. of Mechanics
 TWU - Transport Workers Union

*Source: Aviation Daily

5.1.11 Anticipated Impact of Part 298 Liberalization

The Civil Aeronautics Boards' Economic Regulations, -Part 298 was changed in 1972 to allow commuters to operate up to 30 passenger aircraft without detailed economic regulation by the Board. However, this has not changed the aircraft plans of most commuters. First, there are few aircraft available in the 20-30 seat range. Second, most carriers cannot afford the capital outlay to buy larger aircraft. Finally, they are unsure of the costs of operating a larger aircraft because of additional maintenance and the addition of a stewardess required by the FAA. Since the time of the survey, however, a few carriers have gained some experience with this size aircraft and the results are promising. Indications are that the increased capacity more than offsets the additional costs.

TABLE 5.7

Subsidy Issues

- | | |
|---|--|
| 1 | Local carrier is actively seeking elimination of all subsidy-eligible points in the near future. |
| 4 | Locals would like to be off subsidy in 5 to 10 years, but will require it until low traffic points can be phased out. |
| 3 | Locals see their role as serving low density cities, and plan to continue such service as long as subsidy is provided. |

5.1.12 Discussion of Table 5.7

The carriers' thoughts on subsidy closely reflect their growth plans as reflected in Table 5.2. Carriers in one group

seek to change their identity and become trunk carriers. They need subsidy during the transformation, but in the long run will eliminate points that are unprofitable without it. Subsidy is considered more of a nuisance than it is worth and the subsidized markets are not envisioned as improving greatly in the future.

Carriers in the second group still see their mission as providing local service, although they do want more long-haul, non-subsidized routes. These carriers have been subsidized from the start and need the subsidy to provide service to small communities. They do not object to receiving subsidy for this service, but could not provide it without government support.

5.1.13 The Bid System

Since the interviews, this proposal has been allowed to lapse by the CAB, and is therefore not discussed in detail. In general, the reaction was unfavorable, largely because the plan was not fully understood. Major objections were that a 3 year contract was too short to finance the aircraft needed to provide the service and that inexperienced operators would bid in low, cut cost by compromising safety and then give the industry a bad name by providing poor and unsafe service. The latter is the classic argument used against the air mail bid system of the 1920s and 30s.

5.1.14 Summary of Carrier Survey

Both the local service and commuter industries are quite diverse in the characteristics of the carriers, their plans and their needs. No one aircraft can possibly meet all their

requirements. Rather, at least three types of needed aircraft were identified, but not many of any one type. The first is a new generation of high speed, pressurized turboprops of 19 or less seats. The new Metro seems to fill this gap. The second aircraft would have about 30 seats. The practicality of this plane may depend on the experience of commuter carriers now using aircraft carrying 20 to 26 passengers. Potential aircraft are all foreign - a revamped Nord 262 or the stretched Short Skyvan. Jet aircraft are not competitive in this size because the markets served are primarily short haul, low altitude segments where the turboprop can outperform the jet. Finally, there is a need for a 40 to 60 passenger, high-bypass ratio jet for some of the local service carriers. This market, however, would probably not exceed 150 to 200 aircraft without foreign sales, or a military or business market.

5.2 Community Survey - Pueblo, Colorado

The most remarkable story used to exemplify "jet appeal" was heard at Frontier. The City of Pueblo agreed to underwrite Frontier's operation of a jet from their city to the extent of \$4,000 a month for up to 6 months. To see why the community thought jet service was so important, a day was spent with civic and community leaders, and their responses recorded.

Pueblo, Colorado is an industrial and farming city of just under 100,000 people, located 106 miles south of Denver and 38 miles south of Colorado Springs. At one time, the city was served by four certificated carriers. In fact, the El Paso-Pueblo route was the first awarded to Varney, the predecessor of Continental Airlines. However, as the trunks acquired larger aircraft and free-ways were completed north to Colorado Springs and Denver, the stop

was deleted by all carriers but Frontier. As late as 1965, Pueblo received non-stop or one-stop DC-3 (and limited Convair 580) service to 10 cities, with one non-stop and 5 one-stop flights to Denver per day by Continental and Frontier. By 1967, Continental had left the market. Frontier still provided non or one-stop service to 7 cities with 4 non-stops and 2 one-stops to Denver. In 1970, only 5 cities were connected to Pueblo by non or one-stop flights. Service to Denver had dropped to one non-stop and 4 one-stops by Frontier. Three non-stop flights to Denver were offered by Trans Central, a commuter with twin Cessnas, for several months, but were eventually stopped.

According to local interests, the quality of the service deproved even more than its frequency. Flights were cancelled or late. Since most Denver flights stopped at Colorado Springs, they never gained enough altitude to avoid a local area of turbulence created by the mountains. The number of passengers using the airport dropped off from 40,000 in 1968 to 30,000 in 1970.

Then, two unrelated events took place. First, Frontier went through a change of ownership and management. The new officers began to stress service and service reliability. Second, Walter Berry, a retired local businessman, became the head of the Transportation Committee of the Chamber of Commerce, and eventually the Pueblo Airport Director of Aviation.

For years, the Chamber of Commerce had struggled with the broad problems of transportation to the city. Mr. Berry decided to attack one problem at a time and, as a pilot and former fixed base operator, felt air service should be the first topic.

Mr. Berry's approach was to treat the problem as a business venture and to open a dialogue with the new Frontier management. A 100% sample of all tickets written by Frontier or local travel agents was taken to determine the destinations of the Pueblo air traveller. A professor at the local college was hired to conduct a market survey to see why people did not fly. Unreliable service was the major reason, but many people thought Frontier was still flying the long retired DC-3 or that the price was too high. As a result, Mr. Berry was convinced that the community could potentially generate many more passengers. The problem was getting them out of their cars and onto the airplane.

During this period, Mr. Berry received the active support of the city manager, Mr. Fred Weisbrod, and the president of the Chamber of Commerce, Mr. Cal Snyder. They all realized that there was nothing really wrong with Frontier's service, particularly under the new management. But people in the town had gotten into the habit of "bad-mouthing" the service and the airline. It is not clear who generated the idea, but jet service was adopted as the rallying point to change public opinion.

When first approached, Frontier's immediate reaction was that the traffic could not support jet service, and that no aircraft were available anyway. Mr. Berry and Mr. Ray Seybold, a local travel agent who was Frontier's Station Manager at the time, went through Frontier's entire fleet assignments until they located a jet laying over at Denver at night with its first departure at around 9 A.M. This aircraft was available for an early morning flight from Denver to Pueblo and back.

Once more Mr. Berry approached Frontier. Realizing that Pueblo's interest was serious, Frontier's Bill Wayne, Vice-Pres-

ident of Local Service Marketing, instigated a study of the proposed operation. After a detailed profit and loss analysis, Frontier concluded the service would lose \$48,000 per year. However, Frontier was still interested in introducing jet service and proposed a risk-sharing plan to the city. After a short period of negotiation, Pueblo agreed to underwrite Frontier's losses up to \$4000 per month for a 6 month trial period. The funds were to be taken from airport funds and not from the city's tax revenues which eased passage of the plan through the city council. Frontier also filed for a number of joint and through fares which came into effect 6 months after the experiment was begun.

A joint advertising and public relations campaign was instituted by Frontier and the Chamber of Commerce, based on a "use it or lose it" philosophy. This was an effective foil for community critics who had complained about the quality of air service. Now they had what they wanted for at least 6 months, and if the experiment failed, it would be because the community had not supported it.

The publicity generated additional passengers even before the jet was introduced, but freight response lagged. However, in the fourth month of jet service freight movements increased dramatically. This was followed by another surge in passenger growth during the sixth month as the joint fares were introduced. (See Table 5.8) At the end of the sixth month, Frontier notified the city that no further subsidy would be needed.

TABLE 5.8
Passenger Enplanement Comparison
Pueblo Municipal Airport

Source: Mr. Lyle Sharp; Pueblo Director of Aviation

	1970					
	Pas'grs Boarded	% Change From 1968	Pas'grs Boarded	% Change From 1970	Pas'grs Boarded	% Change From 1971
January	1,284	-7	1,330	+3	1,631	+23
February	1,072	-11	1,126	+5	1,642 (2)	+46
March	1,253	-22	1,368	+9	2,017	+47
April	1,109	-34	1,524	+37	2,153	+41
May	1,194	-22	1,433	+20	2,123	+48
June	1,255	-36	1,595	+27	2,344	+47
July	1,511	-16	1,631	+8	2,364	+45
August	1,466	-22	1,856	+27	2,622	+41
September	1,324	-14	1,509 (1)	+14	2,174	+45
October	1,354	-21	1,637	+21	2,045	+25
November	1,174	-14	1,418	+21	2,125	+50
December	1,385	-23	1,756	+27	2,484	+41

1. Jet introduced.
2. Fares Reduced.

Not only had passengers responded to the jet, but also to air service in general. More people flew the Convairs than ever before. People had become air conscious once more. By the end of 1972, the first full year of jet operation, passenger boardings had increased by 80% over 1970, the last totally non-jet year. Freight increased by a factor of 3 over the same time period.

Several people were asked for their reactions now that the gamble had been successful. Mrs. Pat Kelly, City Councilwoman commented that it was a matter of education. Once people flew and saw the

benefits, they flew more often, even on the Convairs. Good air service and particularly jet service creates an image of a prosperous, successful community and so the experiment was successful.

Mr. Weisbrod, the city manager, felt that role of government is giving people what they wanted. If nothing else, the experiment quieted critics. He also felt that it should not be considered unusual for a city to subsidize air service. They subsidize public transportation, golf, tennis and the like. The city looks for job creation and will invest in proportion to the number of jobs that can be generated. Each job is equal to a \$10,000 saving in welfare payments and so any project that generates 5 or more jobs is eligible for city support. By this criteria, he felt the investment in new jet service has more than paid for itself, although he admitted it was difficult to trace the total number of jobs created.

Mr. Weisbrod said the city acted on the belief that jet service and a good airport are important to a community. There was no study to back this up. It was purely belief. But it fit with their overall community development. There was an activist city government after years of a "hands off" policy. All the streets in the city were paved for the first time. It was a period of excitement, and the idea of jet service fit in.

In summary, it was not that people preferred to ride jets. The jet was made a symbol of civic pride and used as a tool to increase the use of the airport, encourage industry and create jobs in the community. Mr. Berry stated that to this day, many people flying who once drove don't know whether they are on a jet or not. But they do know that Pueblo is a city with jet service.

5.3 Manufacturer Survey

Interviews were conducted with Beech, Cessna, Fairchild and Grumman. Consequently, Boeing, Douglas and Lockheed were visited. Beech and Cessna are primarily manufacturers of light aircraft and Fairchild and Grumman are primarily manufacturers of military and medium sized civil aircraft. Boeing, Douglas and Lockheed are known for their production of larger military and civil aircraft. The general question of the market for commercial aircraft in the 19 to 60 passenger size was explored.

5.3.1 Market Characteristics

The manufacturers felt that some demand for new aircraft in this size range exists. The market breaks down into three categories. The first is the 19 passenger size. This is the largest size that can be flown without a stewardess and is approximately the maximum size that can be designed under the 12,500 lb. gross weight breakpoint for certification and maintenance. The second category is the 30 passenger size, which is the largest that can be flown by commuters without special exemption. The third category is the 30 to 60 passenger range which does not have definite break points within it, other than the addition of a second stewardess at a 50 passenger capacity.

There is little room for new aircraft in the first category since the Beech 99, DHC Twin Otter and Swearingen Metro have this market well covered now and into the foreseeable future.

There is some disagreement in regard to the second category, the 30 passenger size. The question is whether the regional carriers would buy aircraft in this category. If they do not, the remaining market of commuter, corporate, and foreign customers is

too fragmented to allow a single aircraft to sell in sufficient quantity. Manufacturer surveys indicated that four of the eight regionals could conceivably replace their existing turboprops with a 30 passenger turbofan. If so, the market would be large enough for serious consideration. (Survey results, however, indicated that these carriers are not psychologically attuned to this small an aircraft.) In regard to powerplant, the turbofan is favored, but not unanimously, at this size.

In regard to the third category, the 40 to 60 passenger size range, the replacement of the regionals existing turboprops with turbofan aircraft represents a good, stable market. However, this size was outside the current range of interest for Beech and Cessna and would be a stretch for Grumman. Fairchild is already involved in the marketing of foreign aircraft in this size range and would probably not compete with itself. Two of the larger manufacturers felt there was a market for an aircraft of this size, and that it be profitable to produce provided only one manufacturer entered that market. However, they concluded that there were better investments for their limited corporate funds. Furthermore, a new aircraft would face stiff competition from used turbofan equipment from the trunks, particularly the DC-9-10, selling below the price of a new, 40 to 60 passenger plane.

5.3.2 Design Characteristics

Any new aircraft should be as simple as possible in order to meet cost and time constraints. Pressurization and retractable gear are required, but STOL capability is not desired or necessary in the low/medium density market. The Q-Fan is very interesting but too complicated and heavy for this type of ap-

plication. Aerodynamics and structures should be strictly state of the art, stressing simplicity and durability.

5.3.3 Costs

A development cost of \$90 million and a production cost of \$1.8 million per aircraft was representative of all four smaller companies for a 30 passenger turbofan. This gives the price vs production run relationship shown in Figure 5.1. The light aircraft manufacturers would have lower production costs than larger companies for low production runs. Crossing the 12,500 lb. weight limit or going to a turbofan triples the certification costs and drives development costs up 30%. Two of the large manufacturers indicated similar costs per aircraft, but with lower development and higher production costs. The third manufacturer estimated the cost to be twice these figures, but admitted that this figure was probably high.

5.3.4 Government Technical Assistance

The manufacturers felt that research leading to further reductions in the cost of turbofan engines is needed. The new Lycoming ALF 502 is a step in the right direction but the goal should be to reduce the purchase cost per pound of static thrust to that of the turboprops. Other important areas are new low speed airfoils, reducing the cost of fatigue life certification, and better anti-icing equipment.

5.3.5 Government Regulatory and Financial Assistance

Any plan which would reduce the manufacturer's risk in developing a new aircraft would be helpful. This could take many forms such as guaranteed loans, risk sharing with the manufacturer, or by increasing the economic health of the customers through conventional subsidies or a bid system. However, any

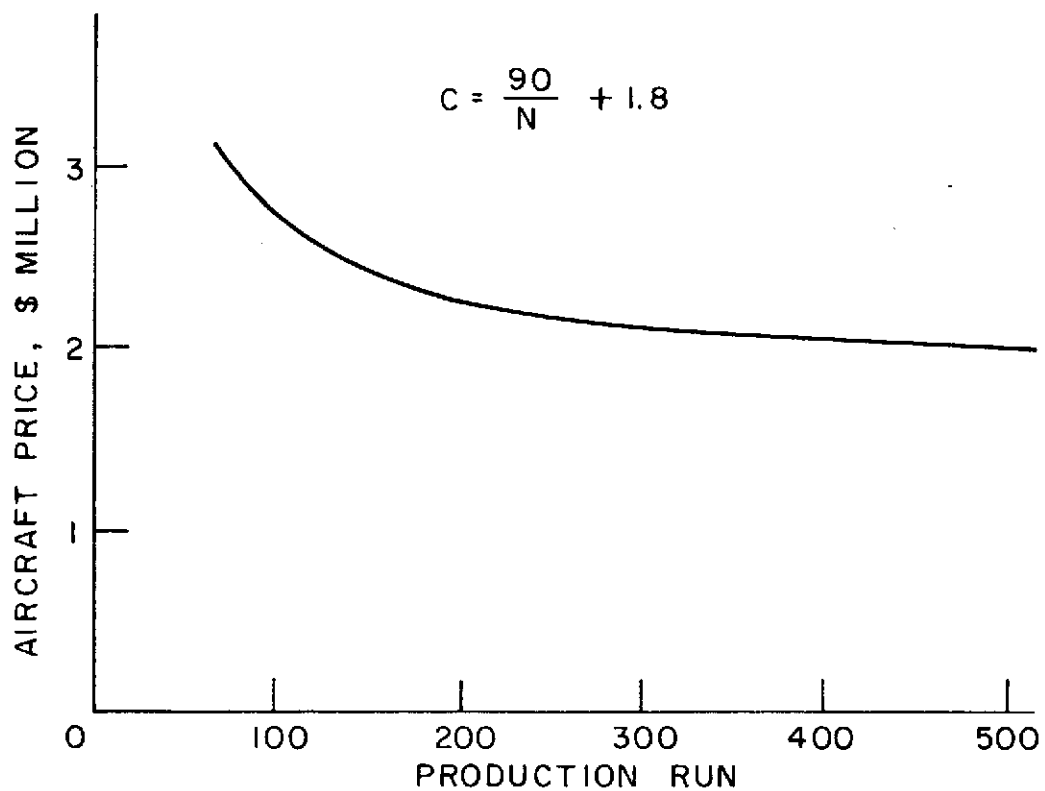


FIGURE 5.1 PURCHASE PRICE VS PRODUCTION RUN FOR
NEW SMALL JET TRANSPORT

such system must remain in effect long enough for both the manufacturers and the airlines to make realistic long range plans. Some manufacturers are very reluctant to get into any market which is dependent on government regulation because the regulations are subject to change. There is also great concern about the general instability of the commuter airlines, and the resulting wide fluctuations in aircraft orders. In summary, the greatest contribution the government could make would be to increase the general health and stability of the low/medium air transportation industry.

5.3.6 International Markets

Several manufacturers had looked at the potential for a 30 to 60 passenger aircraft for use by developing countries. They are concerned that the new nation will select a non-U.S. aircraft to serve its remote towns and cities because no U.S. plane exists in this size range. Then, when these markets grow and could support a U.S. produced aircraft, the country will already be committed to the other nation and continue to buy from them.

However, the aircraft needed by developing countries and that needed by the U.S. local service carriers are not the same. The new nation needs cargo capacity, not passengers. Since many of these nations are in Africa, South America and South East Asia, the aircraft must have high temperature, high altitude performance. It must be able to operate out of unimproved fields.

It was suggested that the government should underwrite the cost of this type aircraft for foreign relations purposes as we does with some military sales. It would be an investment in

future, unsubsidized aircraft sales which help the balance of payments. If the local service carriers found the aircraft useful also, so much the better, but it should not be designed with such common use in mind.

6. Computer Network Analysis

6.1 Introduction

Issues of importance to low density short haul air transportation were investigated in a number of scenarios using a regional airline fleet assignment model. Four regional carriers were examined to see 1) the suitability of a 40 seat modern jet to the existing operations, 2) the usefulness of a light turboprop aircraft of less than 20 seats in providing low density service and 3) the financial advantages of providing subsidized service using commuter air carriers rather than regional carriers.

The profit oriented decision making process of an airline management was modeled using Fleet Assignment model #4 (FA-4), a software package created at the FTL. FA-4 attempts to choose aircraft and serve routings for an airline in such a way as to attract the greatest clientele at the least cost. The basic attributes of the model are:

- 1) the objective function is the excess of revenues over costs.

- 2) the airline route network can be served by a selection from a broad choice of non-stop, one-stop, and two-stop aircraft flights called routings.

- 3) any aircraft in the airline's fleet may fly any routing in the system.

- 4) the number of passengers carried in any city pair market

depends upon the existence of seating capacity on non-stop, one-stop, or two-stop flights and also upon the daily frequency of these flights.

5) a minimum level of service for any city pair market (in terms of flights per day) or any city (in terms of departures per day) may be specified.

For costs, the program uses direct operating costs (DOCs) for the aircraft, and marginal indirect operating costs (IOC's) for passenger handling. Revenues are ticket income at a fixed yield.

6.2 Conceptual Discussion of the Network Model FA-4

Fleet Assignment model 4 is stated in a linear programming formulation. A series of constraints are defined, and an objective function is optimized subject to these constraints. The constraints are:

1) The passengers (and hence the revenues) in any given city pair market cannot exceed a certain value. This value rises as the level of service (daily frequency) in a market rises.

2) The level of service in any city pair market is the sum of all the direct and multistop flights which connect the two cities. The value of a multistop flight or a flight by a slow aircraft in contributing to this level of service is less than that of a nonstop jet flight.

3) A minimum number of departures a day from certain cities may be specified. It does not matter by which aircraft the

minimum departures are flown, or to which destination.

4) on any flight between two cities the load factor due to both origin-destination passengers and passengers originating before the beginning of the hop or having destinations beyond the end of the hop is not permitted to exceed a maximum stated on board load factor.

The objective function merely states that the sum of all the revenues derived from passengers attracted to the service less their indirect handling costs, and minus the sum of all the block hour costs from all the aircraft-routing combinations chosen to be flown must be maximized. This maximizes total contribution to overhead or total profits.

6.3 The Value of Multistop and Prop Flights in determining the level of service.

In any given market the level of service in equivalent frequency depends on both the number of stops and the aircraft type. Thus a non-stop jet flight is 1.0, a one-stop jet is 0.9, a two-stop jet 0.8, a non-stop turboprop 0.95, a non-stop light plane 0.85, and so on. Thus a one-stop jet flight twice a day plus one turboprop non-stop flight would produce an equivalent frequency of $2 \times 0.9 + 0.95 = 2.75$ flights per average day.

The 1.0, 0.95, 0.85 weighting factors for jet, prop, and light plane attractiveness were standard. The weightings for number of stops depended somewhat on the length of the route,

with longer routes penalizing an intermediate stop less.

6.4 Data Sources for FA-4 Studies

The cost and demand data used in the FA-4 studies of regional carriers came, as much as possible, from published CAB figures for the year 1971. Demand data was derived from the on line Origin-Destination data (table 10). Existing levels of service were determined from the Official Airline Guide (OAG) for the period. Aircraft block hour costs came from Aircraft Operating Cost and Performance Report. For the new jet design (called the US-40) and for the DHC-6 (Twin Otter) the ATA formula was used to establish the ratio of block hour costs to those of aircraft actually in service. The depreciation was left out of the block hour costs. A capital cost designed to approximate the dry lease cost of the aircraft replaced depreciation.

In each case each airline was permitted to have in its fleet the aircraft it already had, plus a forty seat jet, the US-40, much like the Falcon 30T in design. The Twin Otter was also available, as a representative commuter light plane design.

Routing options included both existing flight patterns and currently unused routings permissible within the existing route awards.

Minimum levels of service to each community were set at 4 departures per day or at the existing levels, whichever were lower. Large hubs had no minimum levels of service.

6.5 Details of Regional Airlines Studied

Four regional airlines were studied. First Ozark was examined as being most typical - having average stage length and average trip length near the industry means (see table 6.1). Ozark also has both low density isolated and low density non-isolated markets. The Ozark study was the pilot study and as such explored more blind alleys than the later studies. The later studies benefited from several refinements in technique which did not apply to the Ozark case.

Later studies were made of Southern, because of the high proportion of low density non-isolated markets, and of Frontier and Hughes Air West, because of the preponderance of isolated subsidized markets.

The Ozark case study is explained in detail, much of which echoes in specific terms the general description above. The studies of Southern, Frontier, and Air West will be summarized in table form, since the methodology is identical.

6.6 Ozark Case Study

The study attempted to predict the effect of introducing a 40 seat jet aircraft into the route network of a regional carrier. The exercise is the same as would be carried out by an airline in determining the suitability of an aircraft for purchase. In effect the airline assumes it has its present fleet plus an unlimited supply of new aircraft, and asks which aircraft can best be used.

Table 6.1 COMPARISON OF REGIONAL AIR CARRIERS IN 1970

	<u>Trip*</u> <u>Length</u> <u>(mi)</u>	<u>Stage</u> <u>Length</u> <u>(mi)</u>	<u>Stations</u> <u>Served</u> <u>-</u>	<u>Aircraft</u> <u>Total</u> <u>-</u>	<u>Scheduled</u> <u>Boardings</u> <u>(000)</u>	<u>Passenger</u> <u>Revenues</u> <u>(\$000)</u>	<u>Subsidy</u> <u>-</u> <u>(\$000)</u>	<u>Profits</u> <u>-</u> <u>(\$000)</u>
Allegheny and Mohawk	275	182	70	102	8,200	197,000	3,700	5,300
Frontier	392	166	85	47	2,400	75,000	1,500	400
Southern	238	143	54	38	1,600	37,000	4,600	-1,500
Hughes/ Air West	281	172	72	45	2,400	54,000	7,100	-4,700
North Central	204	121	69	49	3,700	77,000	4,900	6,900
Piedmont	284	130	51	43	2,700	63,000	3,400	1,700
Texas Int'l	263	160	54	41	2,200	52,000	4,900	-3,500
Ozark	253	150	50	38	2,400	56,000	3,800	1,500
TOTAL	257	156		403	24,800	612,000	33,900	6,300

*1969 Data, the last year reported.

The new aircraft can enter the system either by direct replacement of existing aircraft on existing routings, or by replacement of sets of routings with new patterns serving the same passenger markets. These decisions are made for the whole route network by the linear programming fleet assignment model FA-4.

6.6.1 Discussion of Inputs for Ozark Case Study

A. Indirect Operating Costs (IOC's)

Certain indirect operating costs were included in the total operating costs for the case study. This was done, as normally would be done at an airline, so that an increase in the size of operations will not be recommended unless all the actual costs of such expansion are accounted for. Thus the long run marginal indirect operating costs were included:

Marginal IOC per passenger mile = \$0.0025
 Marginal IOC per aircraft mile = \$0.02
 Marginal IOC per passenger boarded = \$2.00
 Marginal IOC per aircraft departure = \$12.00

These numbers are estimates in keeping with generally accepted costs for regional carriers, and agree with Ozark's 1971 reported costs.

B. Direct Operating Costs

The direct operating costs for each aircraft were expressed in dollars per block hour. Ozark uses DC-9-30, DC-9-10, and FH-227's. Block hour costs without depreciation were available for Ozark from the CAB's Aircraft Operating Cost and Performance Report,

Vol. V. Ozark also operates DeHavilland Twin Otters (the DHC-6), but no cost figures are yet available. For both the DHC-6 and the US-40, the hypothetical modern 40 seat jet aircraft being tested, DOC was developed by the ATA 67 formula. Table 6.2 compares the total aircraft available. The ATA DOC's for all four aircraft were used to establish their relative DOC's and the ratio of ATA to reported DOC's for Ozarks DC-9-30's and F-227's established the ratio of ATA to Ozark's costs for the US-40 and the DHC-6.

Included in DOC in place of depreciation is capital costs. This cost category includes both depreciation and interest on the capital invested in the aircraft. The cost of capital was assumed to be 8%. 85% of the aircraft price was treated like a 10 or 12 year 8% mortgage with constant annual payments. The other 15% of the price, the residual value at the end of the depreciation period, was financed at a flat 8% a year. This procedure was adopted to ensure a proper inclusion of the capital costs of investing in a new aircraft.

Block times for the DC-9 and FH-227 were derived from the Official Airline Guide (OAG). For the US-40 and DHC-6 block times were estimated.

C. Airport Landing Fees

Landing fee for all airports were assumed to be \$0.18/thousand lbs. gross take off weight. The exceptions were LaGuardia, O'Hare, and Dulles, where the values were \$1.20, \$0.25, and \$0.20 respectively.

Table 6.2AIRCRAFT COSTS FOR OZARK AIRLINES

	<u>DC-9-30</u>	<u>FH-227</u>	<u>DC-9-10</u>	<u>US-40</u>	<u>DHC-6</u>
Seats (Ozark)	97.0	45.7	74.0	40.0	19.0
Gross Wt. (lbs. x 10 ³)	109.	45.	91.	43.	12.5
Ozark DOC* \$/hr. @ Stage length	325 @219	220 @103	403 @221	N.A.	N.A.
ATA DOC* @ Stage Length	358 @200	185 @100	349 @200	257 @150	127 @100
Case Study DOC*	390	193	390	267	136
Purchase Price (10 ⁶)	\$3.5 (used)	\$0.8 (used)	\$1.8 (used)	\$2.5 (used)	\$0.65 (used)
Depreciation Period (years to 15%)	12	10	12	12	10
Utilization (hrs./year)	2500	2500	2500	2500	2500
Capital Costs (\$/hr.)	\$169	\$37.8	\$87	\$121	\$31
DOC with Capital Costs	\$559	\$231	\$477	\$388	\$167
Effective Cruise Speed**	418 mph	220 mph	418 mph	400 mph	165 mph
Zero Distance Block Time**	14 min	7 min	14 min	7 min	5 min
Intrinsic Appeal Factor	1.0	1.0	1.0	1.0	1.0

*Without Depreciation and rentals

**From OAG data; US-40 Assumed

D. Minimum Levels of Service

In a reasonable approximation of the minimum levels of service enforced by the CAB, at least 4 departures per day were required at all points on Ozark's system, except where less service currently existed. The destination city was not specified, so the routing decision was left in the hands of the optimization procedure.

E. Revenues and Yield

Ozark received a yield of 80.6% of coach fare including tax in 1970 operations. The revenues per passenger were expressed as 80.6% of jet coach fares. Where jet coach fares were lacking, prop fares, which usually are \$1 or \$2 higher, were used.

F. Demand

The basic demand function for a city pair relates the travellers attracted to the level of service as in Figure 6.1. One point on the graph was available from the combination of on line origin-destination (O-D) data for Ozark for the 12 months preceding April 1971 and the OAG for the period. The shape of the curve was determined from the formula:

$$Pax = KT^{\alpha}$$

Where K is a constant whose value is established by the known data point.

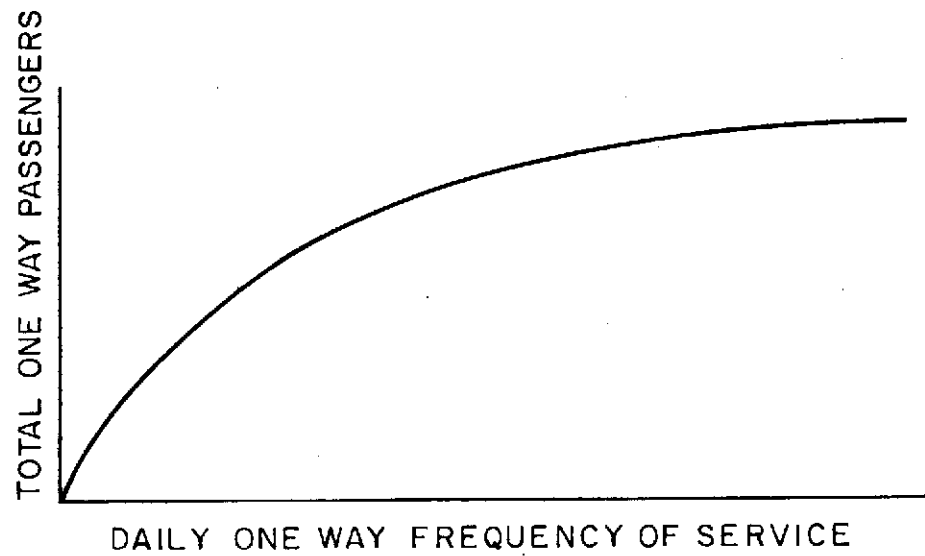


FIGURE 6.1 A TYPICAL DEMAND vs FREQUENCY
CURVE FOR A SINGLE CITY PAIR MARKET

α is the time elasticity of the market, assumed to be - 1.3 from analyses of short haul markets in the Northeast Corridor.

T is total trip time, and includes an hour of access and egress, a half hour of boarding and take off plus a cruise time dependent on distance. In addition T includes wait time, defined as $8 \text{ hrs} \div \text{daily frequency}$. Wait time is an index of the schedule convenience. It was used in the calibration for α .

If competitive services exist, the traffic is split between Ozark and the competition so that Ozark receives a market share equal to its frequency share.

If service is with one or more stops, the equivalent frequency value is reduced by the ratio of total travel time non-stop to total travel time multistop. A stop adds $\frac{1}{2}$ hr. to the trip.

If service is offered with a faster (or slower) aircraft, the equivalent frequency value is the ratio of total trip times, with the cruise time portions adjusted for the aircraft speeds.

All city pair markets in excess of 5 outbound passengers a day were included. In addition, occasional smaller city pair markets were included if they were incidentally served by some routings. Four stops, Lake of the Ozarks, Mo.; Sterling-Rock Falls, Ill.; Kirksville, Mo.; and Rockford,

Wisc. were deleted from the network because they boarded a total of less than 5 passengers per day in all markets.

G. Routings

The basic list of permissible aircraft routings was supplied from the list of Ozark's flights in the June 1972 OAG. Routings having more than four stations had to be broken up into several overlapping four station routings for the current computer coding. This coding prevents service with three or more intermediate stops from being offered. However there was no non-zero city pair demand served only by three stop flights, so no passengers were neglected.

In addition to this basic list of routing options, about 50 non-stop and multistop routings were created where judgment and preliminary results suggested such flights might be useful. Figure 6.2 is the Ozark route awarded by the CAB.

H. Sizes of Input Parameters

In all, there were 49 stations, 140 non-zero city pair demands, and 160 routings to choose from.

6.6.2 Results

Run #1: Reproduce Ozark's Current System

The initial exercise of FA-4 was an attempt to approximate the actual operations of Ozark Airlines. Because of variations in schedules through the year, only an approximation of Ozark's total revenues and passengers was obtained. The yield figure assumed appeared to be a little bit high. Table 6.3

FIGURE 6.2

OZARK AIR LINES, INC.

Route 107

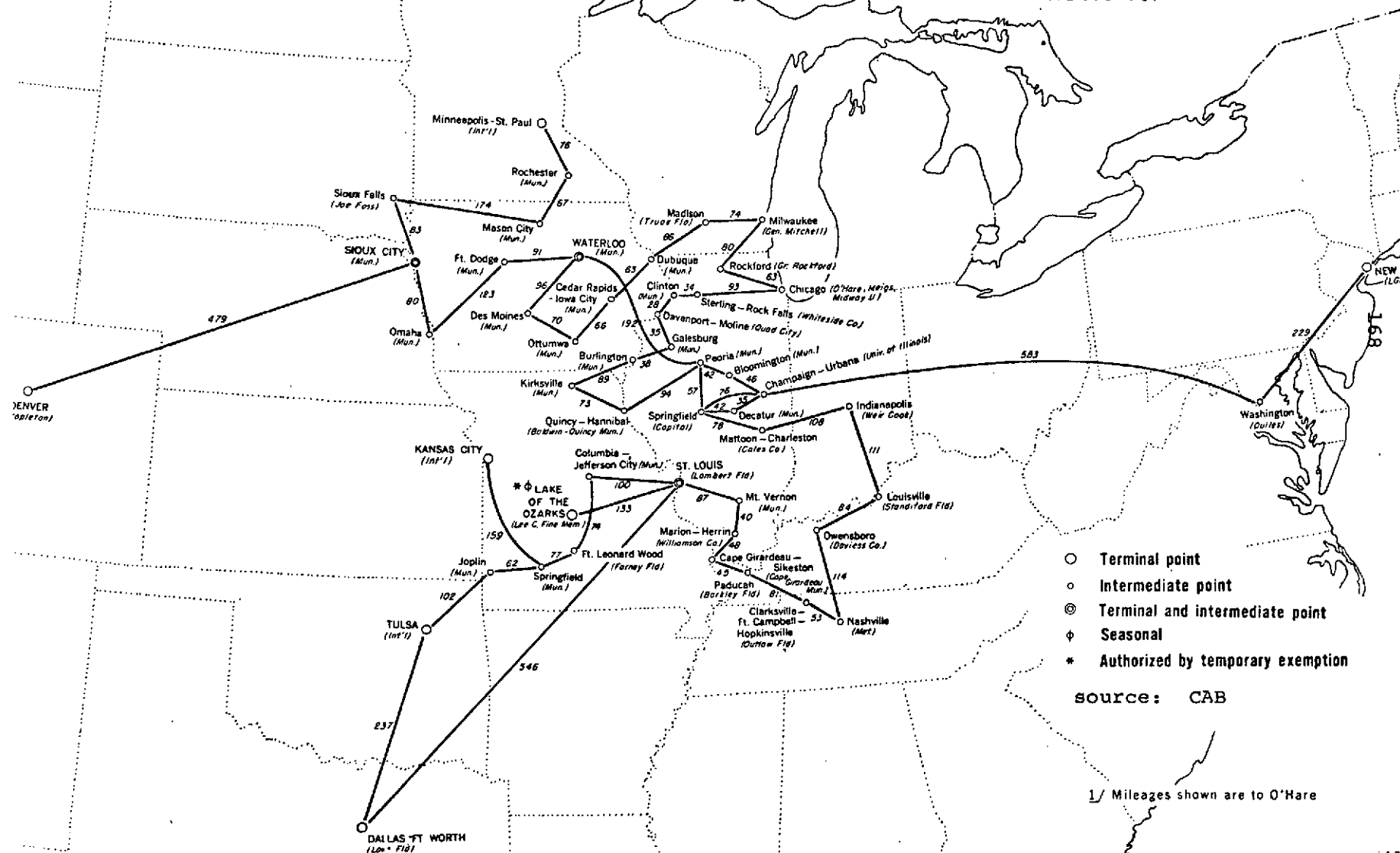


Table 6.3

OZARK AIRLINES FA-4 RUNS - ANNUAL FIGURES

SYSTEM

<u>RUN</u>	<u>REVENUES</u>	<u>PAX</u>	<u>CONTRIBUTION</u>	<u>LOAD FACTOR</u>	<u>DC-9-30</u>	<u>FH-227</u>	<u>DC-9-10</u>	<u>OTHER STATIONS</u>	
Actual Data Reported	\$57.9M	2.55M	xx	43.8%	12.0	21.0	7.0	NA	49
1. Ozarks Routings Forced	59.0	2.51	\$ 9.45	39.1	12.0	21.0	4.6	NA	49
2. Optimal Case	84.3	3.51	26.01	51.5	5.1	49.0	4.2	NA	49
3. Twin Otter Run	81.9	3.40	25.42	54.7	6.2	21.0	7.0	22.6	49
4. US-40 Run	89.8	3.69	27.68	54.5	5.7	16.9	3.7	21.3	49
5. No min. service	82.0	3.38	27.20	53.0	5.2	44.8	4.0	NA	37
6. Commuter Alone	4.8	0.28	0.86	50.5	NA	NA	NA	10.8	(+4)*
7. Min. Service by Commuter	5.1	0.29	0.25	43.4	NA	NA	NA	13.5	(+12)*

* Added to 37 Stations served willingly by the regional carrier

contains the revenue, passengers, contribution to overhead, and aircraft use for each case study.

Run #2: Optimal Routings of Ozark's Current Aircraft

FA-4 optimizes both the routing and aircraft assignments. In so doing a great growth in passengers and load factor was possible on Ozark's system by substituting more FH-227 flights for existing DC-9 flights. The implication is that many of Ozark's markets are "under-frequencied" or served with too large an aircraft.

Run #3: Optimal Routings with Twin Otter Added to the Fleet

The addition of the Twin Otter was made without permitting the FH-227 to grow in numbers. Since the contribution to overhead is higher with unlimited FH-227's, one might conclude that the Twin Otter is not an overwhelmingly attractive addition to Ozark's fleet. Specialized use in minimum service markets is indicated.

Run #4: Optimal Routings with 40 Seat Jet (US-40) Added to Regular Fleet

A 40 seat jet can successfully replace the FH-227 on just over half the flights. The FH-227 is preferred for the shorter hops. Since in the optimal case the FH-227 had already replaced considerable DC-9 activity, the US-40 is in effect replacing DC-9's as well as FH-227's in an attempt to correct the low load factors and low frequencies in Ozark's markets.

Run #5: No Minimum Levels of Service Specified

In order to estimate the marginal operating costs (exclusive of the costs of keeping a station open in each town) of providing services that create a loss, an FA-4 run was made relaxing the minimum service constraints.

A total of 12 stations are dropped with a savings of \$1.2 million per year. A very small reduction in the need for smaller aircraft occurs.

Run #6: Commuter Assumption of Markets Abandoned by Ozark

The markets abandoned by Ozark in the no minimum service case study were offered to an airline with commuter operating costs. The changes in costs were:

	Ozark	Commuter
DHC-6 DOC per block hour =	\$167	\$125
IOC per revenue pax-mile =	\$0.0025	0.0
IOC per aircraft mile =	\$0.02	0.0
IOC per aircraft departure =	\$12.00	\$3.0
IOC per passenger boarding =	\$2.00	\$1.0

Four of the abandoned cities were served by the commuter air carriers, as well as several other cities and markets. Only 11 Twin Otters were needed.

Run #7: Minimum Service Constraints Filled by Commuters

A second case was run using the markets abandoned by Ozark in order to reduce operating losses by \$1.2 million.

This time the neglected services must be provided by the commuter. For half the cost, the same frequencies of service were provided by commuter airlines. Only 0.4% of Ozark's existing annual traffic is involved in this extension of commuters operations.

6.6.3 Other Case Studies

In addition to this set of seven runs, a number of other special runs were performed on Ozark's system:

Special Study #1: The Effect of Jet Appeal Factors in Aircraft Use Decisions

The use of a diminished prop appeal factor so that, all other things being equal, one propeller flight counted only 80% or 90% as much as one jet flight in attracting traffic, virtually eliminated the use of the FH-227 in favor of the US-40. The FH-227 was used only to serve markets of such very low density that the passengers carried were unimportant. This strong response to jet appeal factors led to the use of an estimate of jet appeal factors in all subsequent analysis of regional air carriers.

Considerable overall market stimulation occurs by replacing the FH-227 with a jet. Table 6.4 contains the details of the special studies.

Special Study #2: The Effect of DOC on the Use of the US-40

A 10% decrease in DOC (including capital costs) allowed

Table 6.4

SPECIAL STUDIES FOR OZARK SYSTEM

<u>STUDY</u>	<u>REVENUES</u>	<u>PAX</u>	<u>CONTRIBUTION</u>	<u>DC-9-30</u>	<u>FH-227</u>	<u>DC-9-10</u>	<u>US-40</u>
1. Jet Effect							
prop = 0.8	\$100.0M	4.17M	\$32.3M	7.7	1.1	3.9	31.8
prop = 0.9	93.5	3.87	\$29.6M	7.2	4.6	3.9	28.0
2. Effect of US-40 DOC							
down 10%	93.1	3.84	30.4	6.5	1.2	3.8	33.2
up on short ranges	86.0	3.55	26.2	5.3	48.0	2.9	3.6
3. Demand Sensitivity							
Demand up 20%	\$117.9	4.81	40.7	9.1	23.7	7.7	19.1
4. Diminished Frequency Effect							
	76.3	3.17	24.5	5.3	21.0	3.0	13.2

the US-40 to replace the FH-227 in almost all cases and also permitted some further encroachment into DC-9 markets. In a second run an increase in DOC was designed to reflect the costs that would be expected for an aircraft designed and operated as for 1000 mile ranges rather than the short haul limitation of 500 miles. With this higher DOC, all US-40 use is replaced by the FH-227.

The US-40 and the FH-227 have similar trip costs and seat costs, and one can replace the other with very little change in overall costs. Additional runs revealed that the total demand for all 40 seat aircraft does not change dramatically with change in DOC. A $\pm 10\%$ variation produces a $\pm 17\%$ variation in aircraft needs.

Special Study #3: Demand Sensitivity

A growth in demand of 25% in all markets did not materially affect the need for small aircraft. Medium sized markets grow big enough to be served by DC-9's, but small markets grow to medium size and need more small plane service. The net result is no change in the need for small aircraft.

It must be borne in mind that very small markets and markets not currently served were not included in this analysis. Growth in these areas could increase the need for 40 seat aircraft.

Special Study #4: Diminished Frequency Effect

By increasing assembled block time and decreasing the length of the travelling day in the demand equation, the importance of frequency in establishing the size of a market can be considerably diminished. However, the results were surprisingly insensitive to such a variation. In general somewhat less market stimulation is possible by increased levels of service, but some efforts still bear fruit. The demand for small short haul aircraft does not materially diminish.

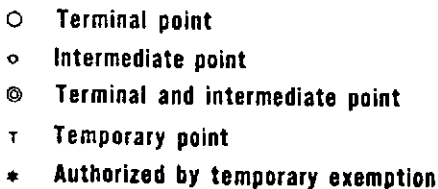
6.7 Southern Airways Case Study

Southern was chosen for a case study because of the high preponderance of hub and spoke, low density non-isolated markets currently served on their system. Figure 6.3 is the Southern route map.

For the Southern case study two changes were made. A new set of IOC values were employed in an attempt to be more accurate. And in addition the sensitivity to jet appeal factors was noted, and corrections made to the equivalent frequency weights of jet and prop flights. Table 6.5 is a list of the changes. Table 6.6 is the aircraft operating costs.

The OAG of the month of October was used to reflect the year of 1971 average operating conditions. City pair demands down to $1\frac{1}{2}$ origins a day were considered.

Route 98



source: CAB

Table 6.5SOUTHERN COSTS

IOC per passenger boarding = \$2.75

IOC per passenger mile = \$0.006

IOC per aircraft departure = \$20.00

IOC per aircraft mile = \$0.30

Equivalent Frequency weight of a jet = 1.0

Equivalent Frequency weight of a large prop aircraft = 0.95

Equivalent Frequency weight of the Twin Otter = 0.85

Table 6.6SOUTHERN AIRWAYS AIRCRAFT OPERATING COSTS

	<u>DC-9-10</u>	<u>US-40</u>	<u>M404</u>	<u>DHC-6</u>
Seats (Southern)	75	40	40	19
Gross Wt. (x10 ³ lbs.)	90.7	43.3	43.7	12.5
Southern's DOC* (\$/hr.) @ Stage	\$368 @184 mi.	N.A.	\$196 @102 mi.	N.A.
ATA DOC* @ mi. Stage	\$369 @100 mi.	\$265 @100 mi.	N.A.	\$127 @100 mi.
Case Study DOC*	\$369	\$265	\$196	\$127
Purchase Price (x10 ⁶)	\$2.0 (used)	\$2.5 (new)	\$0.075 (used)	\$0.75 (new)
Depreciation Period (years to 15%)	15	15	10	10
Utilization (hrs./year)	2700 hrs.	2700 hrs.	2000 hrs.	2000 hrs.
Capital Costs (\$/hr)	\$91.5	\$115.9	\$6.	\$60.
DOC with Capital Costs	\$460	\$381	\$202	\$187
Effective Cruise Speed**	450 mph.	430 mph.	184 mph.	171 mph.
Zero Distance Block Time **	.234 hrs.	.117 hrs.	.117 hrs.	.117 hrs.

*Without Depreciation and Rentals

**From Regression Analysis of OAG data; US-40 Assumed

6.7.1 Results

The first thing of note with Southern is that even with more conservative marginal cost estimates than used for the Ozark case study, the FA-4 optimal solution urges a large expansion of the system by added frequencies and routes. The growth is absorbed by an increase in the DC-9 fleet, with no growth in the need for the 40 seat Martin 404's. See Table 6.7.

Secondly, a 40 seat jet can almost totally replace the Martin 404 in Southern's network.

Somewhat surprisingly the Twin Otter shows considerable savings when used to serve the subsidized markets.

If Southern were permitted to abandon subsidized service, the need for 40 seat aircraft would all but melt away. Twenty stations would be dropped from the system. Savings would total \$4.4 million above fixed station costs.

In the normal course of events, commuter air carriers could be expected to offer service to five of these abandoned points. If subsidized by \$1.2 million, commuters could serve all 20 points.

6.8 Hughes Air West Case Study

Hughes Air West was studied for the 12 months preceding Sept., 1971 -- this is the only available 12 month period of merged operations without a strike. Because of the difficulties of the strikes and mergers, imperfect information was used.

Table 6.7

SOUTHERN AIRLINES FA-4 RUN, ANNUAL FIGURES

<u>CASE</u>	<u>REVENUES</u>	<u>PASSENGERS</u>	<u>CONTRIBUTION</u>	<u>LOAD FACTOR</u>	<u>DC-9</u>	<u>M404</u>	<u>OTHER</u>	<u>STATIONS</u>
Reported Data	\$45.22M	1.875M	x x	43.2%	15	17	na	53
1. Southern routings on FA-4	43.51	1.800	\$ -4.603M	40.2%	17.7	21.1	na	53
2. Optimal Case	73.47	2.747	9.416	51.2%	24.5	19.0	na	52
3. Twin Otter Run	73.32	2.734	10.178	52.5%	25.5	7.4	11.4	52
4. US-40 Run	81.75	3.094	11.400	52.7%	22.7	3.3	15.7	52
5. No Minimum Service	69.58	2.550	13.816	54.0%	24.2	6.7	na	43
6. Commuter Alone	2.53	0.127	0.307	67.4%	na	na	7.5	(+5)
7. Commuter Satisfying Service Constraints	3.62	0.190	-0.914	45.0%	na	na	15.5	(+20)

For instance, 1970 aircraft operating costs were used, and a December OAG was used for scheduling. Still the general results should be accurate in a planning sense. Table 6.8 is the aircraft cost information for Hughes. Other costs were as in the Southern case. Figure 6.4 is the current route map.

6.8.1 Results

Table 6.9 presents the results. Once again by using more non-stop routings with smaller aircraft much market stimulation appears to be possible. The higher load factor achieved permits still further growth. Again the growth does not create a larger demand for the small capacity aircraft.

In Hughes Air West's case, with many isolated markets in the long range end of the spectrum of short haul, a large demand for a 40 seat jet develops. Many new markets are entered, and a surge in revenues and profits occurs. This represents a real increase in service. On the other hand a replacement of the F-27 with the Twin Otter, which saves considerable expense, does not allow expansion to carry more passengers.

Almost half of Hughes Air West's cities are served at a loss, which totals \$9.3 million. Only 4 of the 33 cities might be served by commuters using Twin Otters, but the cost of serving the remaining 24 points by commuters is only \$4.6 million.

Table 6.8HUGHES AIR WEST AIRCRAFT OPERATING COSTS

	<u>DC-9-30</u>	<u>F-27-500</u>	<u>US-40</u>	<u>DHC-6</u>
Seats (Air West)	96	40	40	19
Gross Wt. (lbs. x 10 ³)	109	45	43.3	12.5
Air West DOC* \$/hr. @Stage Length	\$365 @243	\$221 @112	N.A.	N.A.
ATA DOC* @ Stage Length	\$358 @200	\$186 @100	\$265 @100	\$127 @100
Case Study DOC*	\$358	\$188	\$265	\$127
Purchase Price (x 10 ⁶)	\$5.2 (new)	\$1.6 (used)	\$2.5 (new)	\$0.75 (new)
Depreciation Period (years to 15%)	15	10	15	10
Utilization (per year)	2500	2000	2000	2000
Capital Costs (\$/hr.)	\$260	\$129	\$156	\$60.3
DOC with Capital Costs	\$618/hr.	\$315/hr.	\$421/hr.	\$187/hr.
Effective Cruise Speed**	461 mph	225 mph	440 mph	171 mph
Zero Distance Block Time**	.273 hr.	.129 hr.	.129 hr.	.117 hr.
Intrinsic Appeal Factor	1.0	.95	1.0	.85

* Without depreciation and rentals. 1970 data is presented because in 1971 Air West suffered a strike.

** From regression analysis of OAG data; US-40 assumed.

FIGURE 6.4

HUGHES AIR CORP. (d/b/a Hughes Airwest)

Routes 76 and 76F

source: CAB

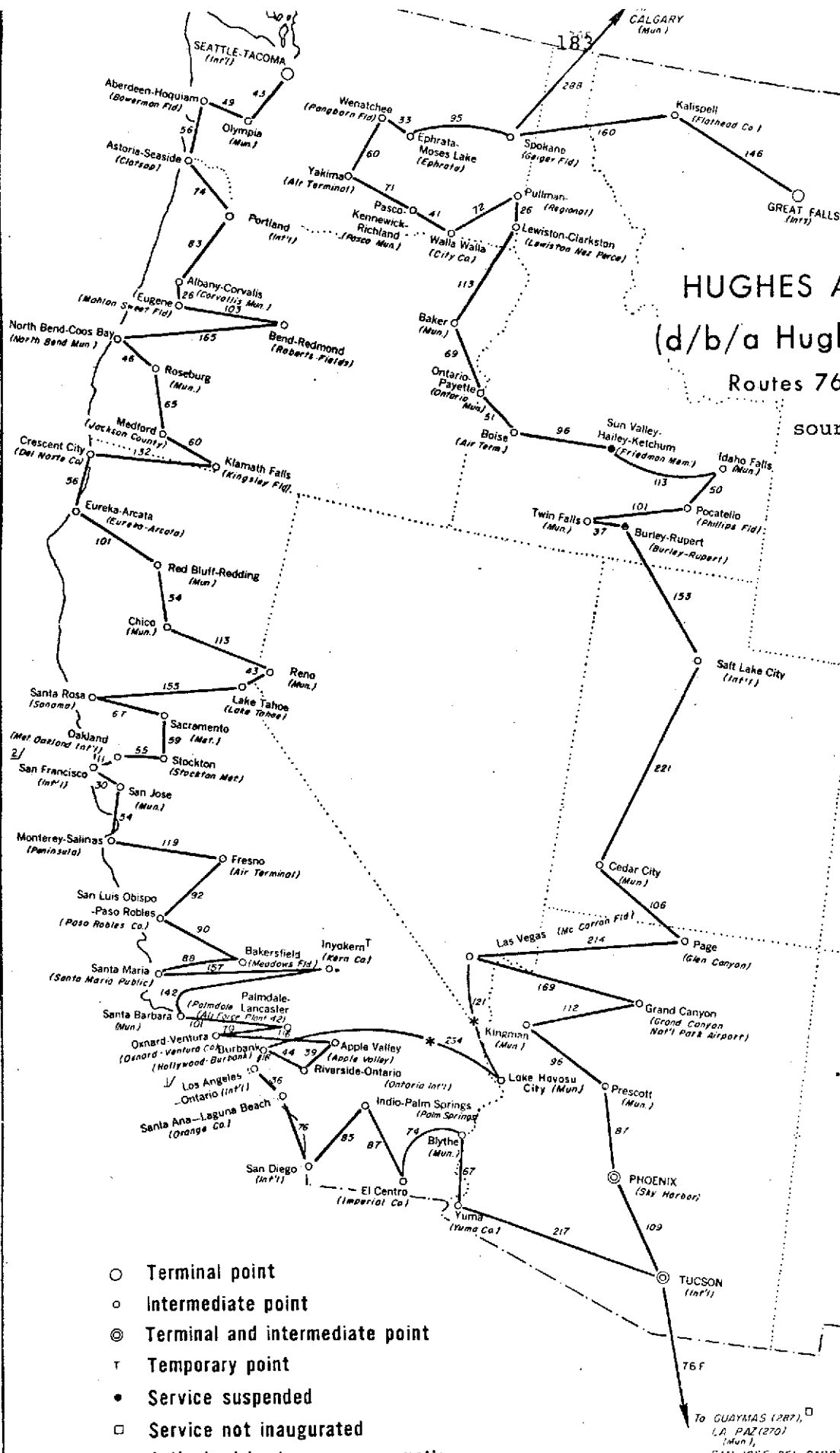


Table 6.9

HUGHES AIR WEST FA-4 RUNS, ANNUAL FIGURES

<u>CASE</u>	<u>REVENUES</u>	<u>PASSENGERS</u>	<u>CONTRIBUTION</u>	<u>LOAD</u>	<u>DC-9</u>	<u>F-27</u>	<u>OTHER</u>	<u>STATIONS</u>
Reported Data	\$79.46M	3.11M	x x	46.1%	19.4	25.0	na	67
1. Air West routings on FA-4	77.20	3.03	\$1.035M	44.0	21.8	21.6	na	67
2. Optimal Case	121.20	4.58	14.971	50.6	30.0	28.1	na	67
3. Twin Otter Run	124.59	4.76	20.036	52.8	30.6	3.9	35.2	67
4. US-40 Run	164.12	6.29	25.166	55.6	25.8	0.0	45.8	67
5. No Minimum Service	111.53	4.13	24.236	53.6	29.5	10.6	na	34
6. Commuter Alone	2.024	0.123	0.190	58.3	na	na	4	(+4)
7. Commuter Satisfying Minimum Service	7.533	0.395	-4.801	36.2	na	na	30.5	(+33)

Table 6.10FRONTIER AIR LINES AIRCRAFT OPERATING COSTS

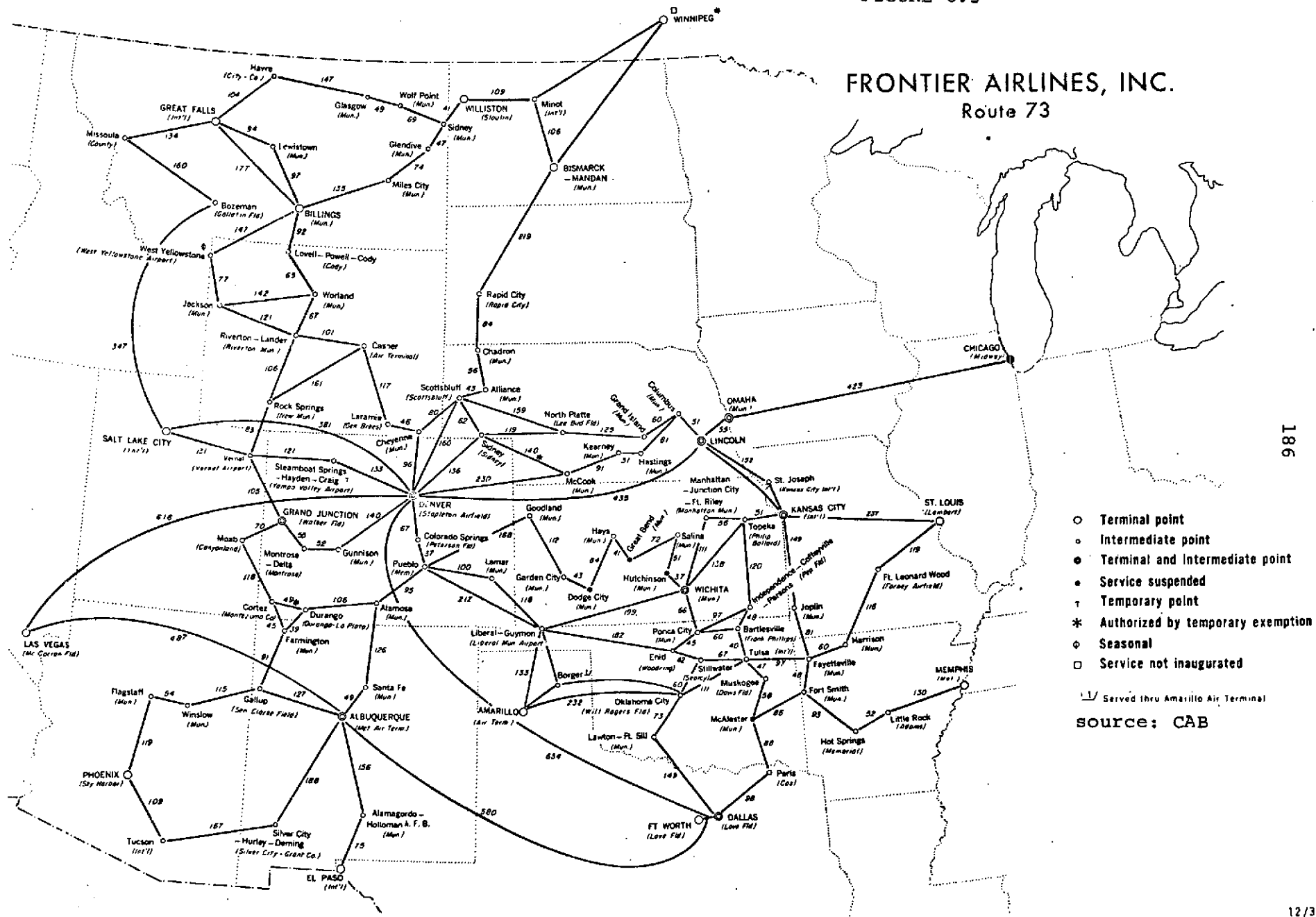
	<u>B727-200</u>	<u>B737-200</u>	<u>CV-580</u>	<u>US-40</u>	<u>DHC-6</u>
Seats (Frontier)	135	97	50	40	15
Gross Wt. (lbs. x 10 ³)	184	155.5	54.6	43.3	12.5
Frontier DOC* \$/hr. @ Stage Length	\$418 @331	\$398 @525	\$275 @120	N.A.	\$93 @93
ATA DOC* @Stage Length	N.A.	\$342 @300	\$184 @100	\$265 @100	\$127 @100
Case Study DOC*	\$418	\$398	\$275	\$300	\$93
Purchase Price (x10 ³)	\$3.6 (used)	\$3.0 (used)	\$0.25 (used)	\$2.5 (new)	\$0.75 (new)
Depreciation Period (years to 15%)	15	15	10	15	10
Utilization (hrs. per year)	2500	2500	2000	2000	2000
Capital Costs (\$/hr.)	\$180	\$150	\$20	\$156	\$60
DOC with Capital Costs	\$598	\$548	\$295	\$456	\$153
Effective Cruise Speed**	507 mph	450 mph	300 mph	430 mph	171 mph
Zero Distance Block Time**	.333 hrs	.275 hrs.	.206 hrs.	.206 hrs.	.117 hrs
Intrinsic Appeal Factor	1.0	1.0	.95	1.0	.85

*Without Depreciation and Rentals

**From Regression Analysis of OAG data; US-40 Assumed

FIGURE 6.5

FRONTIER AIRLINES, INC. Route 73



6.9 Frontier Case Study

The model of the Frontier system suffered slightly in rigor because the system of 94 stations needed to be divided into a northern and southern section in order to fit on the existing software for FA-4. Fortunately by judicious choice of the dividing line and careful consideration of the half dozen demands for flights across the line, a reasonable approximation was achieved.

Frontier was modeled for the year 1971 using the April OAG. Aircraft costs are presented in Table 6.10. Figure 6.5 is the route map. All other costs were as for Hughes Air West and Southern.

Frontier in 1971 used both the Beech 99 and the Twin Otter with 15 seats. Costs, therefore, were available for both. A composite aircraft, the TP15 was used in the run.

6.9.1 Results

A particularly surprising result occurred when the optimal case was compared to actual operations. A combination of 727 and Convair 580 services was used to replace existing 737 services. Sometimes the ratios of 727 to CV-580 frequencies seemed schedulable and sometimes the decision making process of the fleet assignment model needed correction in the face of limitations enforced by scheduling constraints. In general the 737 is probably a better choice than the 727 for many routes, even though the 727 was used.

Table 6.11

FRONTIER FA-4 RUNS, ANNUAL FIGURES

<u>CASE</u>	<u>REVENUES</u>	<u>PASSENGERS</u>	<u>CONTRIBUTION</u>	<u>LOAD</u>	<u>B727</u>	<u>B737</u>	<u>CV580</u>	<u>OTHER</u>	<u>STATIONS</u>
Reported Data	\$79.575M	2.738M	x x	45.8%	3	12	32	4	94
1. Frontier Routings on FA-4	77.148	2.683	\$4.245	37.	3.0	12.0	37.8	4.5	94
2. Optimal Case	106.726	3.449	15.405	49.	12.2	0.0	47.4	na	94
3. Light Twin Case	104.768	3.374	22.170	54.	13.2	0.0	13.8	29.3	93
4. US-40 Case	109.221	3.510	16.532	50.	12.7	0.0	42.3	4.5	94
5. No Minimum Service	104.024	2.818	29.092	55.	12.3	0.0	13.8	na	29
6. Commuter Alone	5.325	0.271	0.647	55.	na	na	na	12.1	(+13)
7. Commuter Satisfying Service Constraints	10.940	0.623	-4.554	34.	na	na	na	53.9	(+65)

The optimal case once again showed some traffic stimulation by increased service provided by the smaller CV-580 aircraft. In direct contradiction of the results exhibited by Hughes Air West for similar routes, the US-40 design was unable to replace the older Convairs even with a small advantage from jet appeal. The light twin, as usual, was able to achieve vast savings (\$6.7 million) in serving the many low density routes on Frontier's system.

A total of \$13.6 million in operating expenses could be saved by eliminating 65 of the 94 stations in Frontier's system. Thirteen of these points could be picked up by commuters without incentive, and another \$5.2 million could persuade commuters to serve all 65 points.

6.10 Case Studies of Commuter Airlines

In addition to the extensive studies of regional airlines, three case studies of commuter airlines were made using FA-4 and whatever imperfect data on costs and traffic could be assembled. Golden West, Air Wisconsin, and Mackey International were studied as representative of three successful large commuters.

Preliminary results suggested that it would not be to the commuters' advantage to cross the 12,500 lb. line and graduate to regional airline costs in their markets. Even under vastly reduced DOC's, larger aircraft were not attractive to the commuters.

The single exception was Mackey International, which operates in markets where frequency of service is less important. Here existing Convair 440 flights could be replaced by a modern jet service at some small savings.

The commuter case studies were not pursued in any detail, since preliminary results left so little possibility that a small jet could be useful.

6.11 Conclusions

The case studies did not come out with any overwhelmingly positive corrections to existing conditions.

A new modern jet of modest capacity could be used to some small advantage to replace existing older propeller driven designs in low density markets. This is true even if the immense capital costs of a new plane are considered in the expenses. However this conclusion is sensitive to the economics of the aircraft design. A higher operating cost would make the new jet not competitive.

If the local service carriers were to abandon the subsidized markets, the need for small aircraft would drop to a third. The existing fare levels do not permit a small aircraft to operate without a loss at reasonable load factors. Indeed even at costs typical of the commuter airlines, existing fares will not support service to most of the subsidized cities. Commuter

airlines can, of course, cut the operating losses by over one half.

Indeed the other major lesson to be learned from the case studies is that a small light twin such as the Twin Otter can often serve very low density markets as efficiently as a new jet design. The difficulty for the jet lies in the cost of flying empty seats in a small market.

The general conclusions are: 1) a small jet is useful only as a replacement for existing small turboprop aircraft and only if the economics are reasonable; 2) the use of such an aircraft is to cut losses rather than increase profits; and 3) the use of a light twin aircraft can approach the savings offered by a modern jet and, in the hands of the commuter airlines, halve the losses incurred providing service to low density cities.

7. SUMMARY AND CONCLUSIONS

The main objective of this study was to determine if there is a potential market for a small, United States manufactured aircraft in the 20 to 50 passenger range similar to the YAK - 40, Falcon 30, VFW 614, to serve the low/medium density markets of the United States. A subsidiary issue that was addressed was how the introduction of such a aircraft would affect subsidy in these markets.

The study consisted basically of two phases. One phase was essentially a market research project to determine the needs of carriers in the medium/low density area- the local service airlines and the commuter air carriers. Discussions were also held with United States aircraft manufactures to obtain their opinions as to the market potential of an aircraft in the 20 to 50 passenger size. Other organizations active in various aspects of the air transportation industry were also surveyed.

Another phase of the study centered upon a computer network analysis of four local service airlines as well as some commuter air carriers. These analysis were undertaken to see the effect of introduction of a new aircraft into the fleets of these regional carriers, as well as to obtain a clearer picture of the number of smaller aircraft that these carriers could profitably operate. Additionally, some other analytic techniques were developed that are useful in studying problems in the low/medium density air trans-

CM

portation area.

The results of the field surveys of the carriers can be summarized as follows:

(a) The commuter air carriers see no need for a small 30 passenger jet for the immediate future (priced at about \$2 million). The commuters feel that the existing turboprops (the Beech 99, Twin Otter and Swearingen Metro) are sufficient to meet their market needs. At their stage lengths (less than 100 miles, generally) the greater speed of the jet is not sufficient to offset the higher cost of the aircraft, as differences in block times would be minimal. Future aircraft for the commuter industry will be additions to the existing fleets, rather than replacements of current generation aircraft. For some commuters with peaking problems, a larger aircraft would be useful, but a turboprop will be sufficient if pressurized and air conditioned.

(b) The local service airlines definitely want a jet aircraft to replace their aging turboprops. The size of the aircraft is partially contingent upon whether the carriers intend to serve low density, subsidized points in the future. Those that do in general are more favorably inclined toward a smaller aircraft, but smaller in their terms is about 60 passengers. Planes in the 30 passenger range are rejected because of segment flow problems, as well as inability to use the aircraft over the complete regional network.

United States manufacturers tend to fall into two categories. The big three of the industry recognize that a market for a small jet (40 - 60 passenger size) exists, but are convinced that their corporate resources are better used for larger aircraft development. The smaller manufacturers feel that a 30 passenger jet could have some appeal for commuters, but do not see a large enough market to justify a development program. On the other hand, aircraft that are bigger (40 to 60 passengers) are felt to be out of reach because of the high development costs, as well as the manufacturers' lack of experience in producing larger aircraft.

The results of the computer model network analysis can be summarized as follows:

(a) Three out of the four local service carriers analyzed could replace their current turboprop equipment with a 40 passenger jet and increase their profits.

(b) All local service carriers could increase their profits substantially by using small turboprop aircraft (such as the Twin Otter and Swearingen Metro) to serve their low density points. The 40 passenger jet would not substantially decrease their subsidy needs.

(c) Commuters generally are flying equipment that is well suited to their markets. A 30 passenger jet does not profitably fit into most of their networks.

The following conclusions are drawn as a result of the study:

(a) In the United States alone there is a large enough market

(about 200) to make a new U.S. designed 40 to 60 passenger jet aircraft a reasonable financial venture; additionally there is considerable world - wide market potential for such an aircraft. The purchase of such an aircraft by United States regional carriers could improve their profitability, particularly with a 40 seat version. The risk to the manufacturer of this aircraft would be in having more than one supplier attempting to meet the demand for this aircraft. An aircraft of this size is not well suited for the low density, subsidized points and, except for increasing profitability of the carriers, will not reduce their subsidy needs.

(b) For commuter and low density markets, the need for a new 20 - 30 passenger high speed jet aircraft is not as clearly established at this time. Continued growth of the commuter industry and longer route segments may eventually require this type of aircraft. For the commuter industry, governmental regulatory changes could be considerably more significant than new aircraft acquisition. Some changes that would have substantial impact would be:

- (1) Restructuring of the low density markets by allowing commuter replacements of local service carriers.
- (2) Extension of operating subsidies to commuters in these markets.
- (3) Expansion of the guaranteed loan program to include commuters.
- (4) Change in FAA regulations (FAR 135) to bring maintenance and crew requirements in line with the CAB's 30 passenger, 7,500lb.

Part 298 restrictions.

Aircraft that serve low/medium density areas, whether of the larger (40 -50) or smaller (30) versions, should be designed with low cost as a major design criterion, together with maximum reliability. There has to date been no U.S. design that has emphasized economy, and a design competition for such a vehicle would be highly beneficial to the U.S. air transportation industry.

BIBLIOGRAPHY

1. Annual Reports of the Civil Aeronautics Authority, 1939-1940
U.S. GPO Washington.
2. Annual Reports of the Civil Aeronautics Board, 1941-1965
U.S. GPO Washington.
3. Civil Aeronautics Board Reports to Congress, 1966-1972
U.S. GPO Washington.
4. Civil Aeronautics Board Reports (Economic Decisions) Vol. 6
July 1944-May 1946, Index Vols. 1-20, August 1938-May 1955,
Index Vols. 1-20 June 1955-April 1960. U.S. GPO Washington.
5. Service to Small Communities, Parts I, II and III March 1972
Staff Study of the Bureau of Operating Rights Civil
Aeronautics Board.
6. Permanent Certificates for Local Service Air Carriers
Hearings before the Committee on Interstate and Foreign
Commerce, House of Representatives, 84th Congress,
First Session on H.R. 526 and H.R. 2225, February-March 1955.
7. David C. Whitworth, A Study of the Civil Aeronautics Board
Policy Toward Route Structure Development of Local Service Airlines,
Master Thesis at the University of Tennessee, Dec. 1970.
8. Public Benefits Provided by the Local Airline Industry-Report No.8
prepared for the Association of Local Transport Airlines
April 1973, Systems Analysis and Research Corporation,
Washington, D.C..
9. George C. Eads, The Local Service Airline Experiment
Studies in the Regulation of Economic Activity, the
Brookings Institution, Washington, D.C. 1972.
10. Handbook of Airline Statistics, 1971, Civil Aeronautics Board,
U.S. GPO Washington, (1972).
11. Subsidy for United States Certified Carriers, Civil Aeronautics
Board, U.S. GPO Washington, (1972).
12. The Long Range Needs of Aviation Report of the Aviation Ad-
visory Commission, January 1, 1973.

13. Commuter Air Carrier Traffic Statistics Year Ended December 31, 1971 Civil Aeronautics Board, Bureau of Operating Rights, August 1972.
14. Pomeroy, Jr., Leslie Klett, 1925-- An Evaluation in Terms of the Public Interest of the Civil Aeronautics Board's Route Strengthening Policy for Local Service Carriers
Ph.D. in Economics, American University 1970.
15. The U.S. Commuter Airline Industry - Its Current Status and Future Outlook, Waldo & Edwards, Inc. Report No. 70-109
Prepared for Department of Transportation, Federal Aviation Administration, Office of Aviation Economics, November 1970.
16. World Airline Record, 7th Edition 1972, Roadcap & Associates Publishers, Chicago, Illinois.
17. Analysis of the Local Service Airlines Aircraft Requirements, 1970-86 1970-1986 - Grumman Corp, December 1970.
18. Market Potential of a Subsidized 30 Passenger Aircraft, Grumman Corp. January 1973..
19. Implications of Future Demand on Short Haul Aviation, Metro, April 1973.
20. Air Transportation Regulation Manual, Federal Bar Association, 1972.
21. Aviation System Planning, R. Dixon Speas, September 1970.
22. Study of Low Density Air Transportation Concepts, Aerospace Corp. May 1972.
23. Regional Air Transportation Study, R. Dixon Speas, November 1971.
24. Comparative Analysis and World Market for Twin Turboprop Aircraft Helio Aircraft Corp., July 1966.
25. Estimate of Hub and Spoke Market for the DHC-7
De Havilland, Canada, October 1972.
26. Joint Community-Airline Fares Petition of the NATC before the CAB on Domestic Passenger Fare Investigation, NATC, July 1972.

27. Application to the CAB to Suspend Service to Bloomington, Ill.
Allegheny Airlines, October 1972.
28. DC-3 Replacement Analysis, Douglas Aircraft Corp., Sept. 1962.
29. Part 298 Weight Limitation Investigation, CAB, 1971.
30. An Analysis of Scheduled Air Taxi Operators, CAB, November 1969.
31. New England Service Investigation, CAB, 1973
32. Commuter Airlines, State of the Industry, NATC, May 1972.
33. U.S. Commuter Industry - Its Current Status and Future Outlook,
CAB, November 1970.
34. Commuter Air Carrier Operations as of September 1970, FAA, 1971.
35. A Proposed New 3rd Level Commuter Short Skyvan, May 1972.
36. Survey of Aircraft Design Parameters Preferred by Commuter Air
Carriers, Grumman Corp., November 1972.
37. Preliminary Study of 30 Passenger Aircraft, Convair, 1971.
38. MIT-NASA Workshop on Airline Systems Analysis, MIT Flight
Transportation Laboratory, July 1972.
39. Investigation of the Local Service Class Subsidy, CAB Docket
No. 23682, Adopted June 16, 1972.